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THE WORLD IS ITS FIELD

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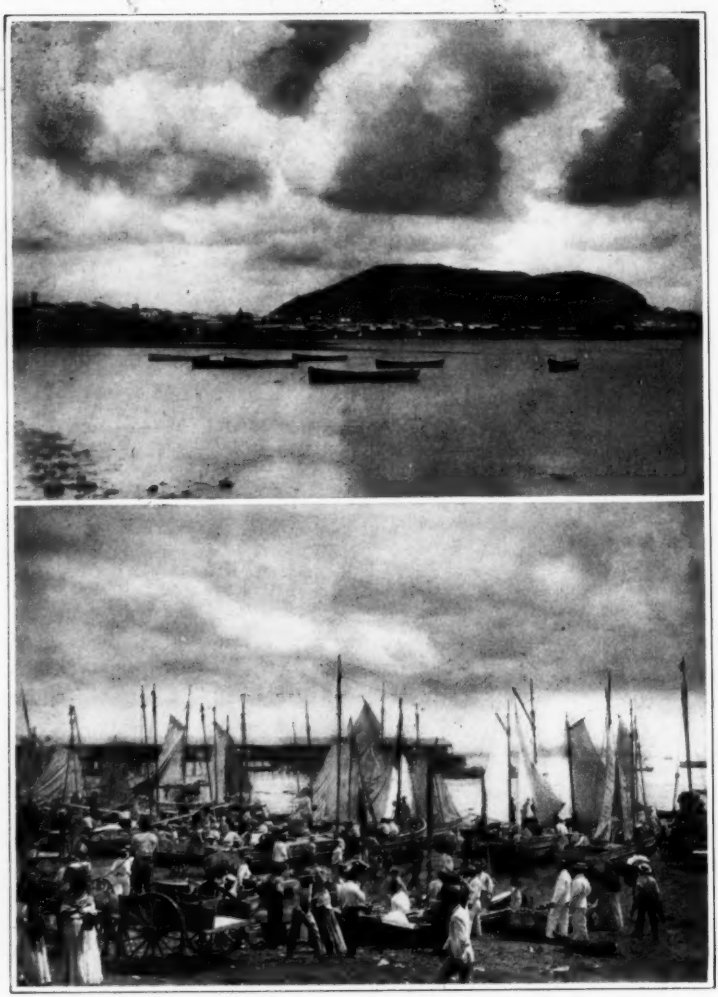
AN ENGINEER'S LIFE IN THE FIELD ON THE ISTHMUS.

By Fullerton L. Waldo.

Mr. Waldo's article follows and amplifies the lines drawn by Mr. John F. Wallace, in his contributions to this Magazine in the preceding three issues, by making clear the fundamental soundness of the Panama Canal proposition, and the nature of the temporary difficulties which have hampered the execution of the plans. A fuller discussion of this point will be found in our Editorial Comment pages.—THE EDITORS.

BOYD EHLE AND HIS PALUNKA MEN.
Travel by dugout canoe on the upper Chagres, at Dos Bocas.

WHEN the new Panama Canal Company turned over to American engineers the job of digging "the big ditch," about two-fifths of the excavation for a lock canal was said to have been done. Among the assets received by the transfer was a lot of dredging and excavating machinery, which was newly painted and whitewashed—in so far as it lay along the railway track—to be seen by the Panama Canal Commissioners as they rode past. With this machinery, it was supposed by some over-trustful persons, the remaining three-fifths of the digging might, in part at least, be done. The late Mr. George S. Morison said no person responsible for the execution of the canal work should be compelled to use the French machinery, and he was just about right. Mr. Morison had



THE PANAMA WATER FRONT, AS SEEN FROM THE SEA AND THE SHORE.

no tact, but he had common-sense and a constructive imagination which enabled him to forecast the event from the beginning. "I hate to eat my lunch with Morison," said one of our foremost electrical engineers to me,—"he always quarrels with the waiter; but I'd trust his judgment sooner than that of any other engineer I know." It was Mr. Morison who advocated putting a match to Colon, with its filthy hovels, and rebuilding the town at a higher level—an idea which any drastic scheme of sanitation must include. Mr. Morison said furthermore that the first two years of work at Panama would have to be devoted to eradicating the results of four centuries of sanitative neglect on the part of the Spaniards: the filth-heaps under the houses, the polluted wells and malarial swamps, the germ-peddling mosquitoes described in Dr. Howard's admirable monograph. The workmen must be adequately housed, and—a prime requisite—good water must be supplied in sufficient quantity.

Instead of adopting Mr. Morison's scheme of prevision and provision, which was a matter of engineering, the War Department permitted the congestion of the Isthmus with a lot of contractors' supplies, prematurely ordered, which is a matter of bureaucracy and maladministration. A resident engineer who went to the Isthmus a year ago had to wait six fuming weeks to get his instruments from the storehouse. The rule ought to be rescinded by which everything in the line of tools or supplies needed by the man in the field is chained up in a government warehouse immediately upon its arrival at the Isthmus. Panama is no place for red tape; nature has imposed conditions sufficiently hard without the superaddition of vexatious official restrictions. One engineer needed mosquito bars for his party, and there were plenty of mosquito bars in the government storehouse. But the weary process of department routine and red-tape kept him waiting so long that he got impatient and stole the mosquito nets, for which larceny he was reported "higher up"—not high enough up, however, to let it be advertised that the administration, at the dictates of a military administrator, withholds from the civil engineers the necessities of life in the tropics, in order to comply with the technicalities of departmental legislation. Col. Roosevelt had the same sort of trouble in the Cuban campaign, as his book on the Rough Riders testifies, and Kitchener in India is similarly handicapped by Downing Street in London. The military *régime* at Panama, in so far as the furtherance of engineering efficiency is concerned, is a failure; in so far as the maintenance of official orthodoxy is concerned, it is a great success.

THE CHAGRES RIVER AT JUAN MINA.

Now let us see what has actually been done since American engineers went to Panama a year and a half ago.

The *crux* of the whole project, as everybody knows, is the control of the Chagres River in flood: the excavation at Culebra is a matter of keeping steam-shovels at work till a volume of earth greater than the cubic contents of Cheops' Pyramid is removed. A great many people think they know just how the Chagres can be made a tractable feeder for the Canal, and many plans have been submitted to the Commission, each indisputably superior to all the rest, which would save the Government nebulous millions of dollars. Mr. Morison's plan was to build a dam at Bohio, creating a large lake with an island —"Bunau Varilla Island"—in the middle, in which lake the water brought down in flood-time by the Chagres might be stored. Recent investigations have shown that the bed-rock at the site of the proposed dam is at much greater depth, and the deep-lying strata are much more permeable by water, than was indicated by the borings upon which Mr. Morison based his project. The man who stood closest to Mr. Morison's engineering concepts—his lieutenant in the

field, Mr. Boyd Ehle—has in the year past under the chief-engineership of Mr. John F. Wallace, made discoveries in the Chagres valley which supply a rational alternative to Mr. Morison's great design, and a working basis for that alternative.

Mr. Ehle first went to the Isthmus with Chief Engineer Anecito G. Menocal (dean of all Isthmian surveys and surveyors) on the Nicaragua survey of 1889. Of his engineer assistants, Carpenter, Anderson, and Boltz had been with Mr. Ehle in Nicaragua; Hayes, Clark, Wells, and McMorrow in the United States; while Obensham, Lindsay, Hortenstine, and Archer were recent graduates of the noted technical school at Blacksburg, Virginia.

Camping chiefly under their hats and sleeping where night found them, Mr. Ehle's own party ran a line through the Continental Divide for an eight-mile tunnel spillway to the Pacific, to handle the great floods of the Chagres valley in the rainy season. Meanwhile a party in charge of R. H. Anderson was doing similar work in the Gatun valley on the north side of the Chagres, locating a second and much shorter tunnel spillway (about four miles) into the Gatuncillo river, whence the line runs into Manzanillo bay, utilizing from Gatun a diversion channel already cut by the French. More recent and more extended surveys have shortened the route. These two tunnel

PALM AVENUE AT ANCON.

POLE SHACKS WITH THATCHED ROOFS.

spillways are to tap a lake formed by a dam at Gamboa, which a third detail of engineers was busy locating while the spillway parties were engaged on opposite sides of the projected lake-area. Plans were made for a dam of concrete, and débris from Culebra, to a height at elevation 200 feet above sea level (about 150 feet above the valley floor). This would safely hold water to elevation 190 feet, forming a lake which would extend nearly 30 miles up the Chagres valley. The Gamboa dam and the two tunnel spillways Mr. Ehle estimates will result in a saving of $26,000,000 on Mr. Wallace's estimate for a lock canal. His official estimates for the two spillways and the dam are given at the end of this article. His very valuable technical commentary on these estimates gives a clear idea of what these surveying parties have accomplished toward the practical solution of perhaps the most difficult engineering problem at Panama.

The first detail—Mr. Ehle's party—established their headquarters at Bas Obispo and started to tunnnel a line up the Chagres valley into the Chilibre drainage. It was not possible to advance a foot without hacking one's way through a tangle of creepers by means of the *machete*. Lizards and gaudy snakes crawled and scuttled everywhere. Buzzards hovered against the blazing tropic sun, monkeys jabbered from the trees and parrots screamed, and insect pests were superabundant about the heads and eyes of the lightly-clad transitmen and levelmen. Amid the profusion of red

A GROUP OF MACHETEROS, JUAN MINA.

and yellow orchids and parasitical air-plants, humming-birds hung and darted, while the ground was alive with "leaf-cutter" ants that climbed the trees and cut out triangular bits of leaves, which they carried away in regularly marshalled columns to grow the fungus on which they feed their larvæ. Here and there one came upon the footprints of the tapir ("mountain cow") or the small tropical deer. A species of grouse and a kind of wild turkey, with jet-black plumage and ruff, allied to the Australian cassowary, furnished an occasional welcome variety in the camp fire. Once in a while a monkey was cooked and eaten, but the appearance of the skinned animal was so suggestively human that few of the college-bred men from the North fancied the diet. The gayest of butterflies and moths—some of them bright blue—lent additional gracenotes of flickering color. But, to tell the truth, it was sometimes hard to appreciate the beauties of Nature in the debilitating tropical heat and humidity, and the plague of insects was almost unendurable. Hundreds of ticks and red-bugs, brushed from every leaf, attached themselves to the skin and produced festering sores; at night the men scratched themselves till they fell asleep from sheer exhaustion, and then went on scratching with involuntary galvanic motions. Chigoes ("jiggers"), a kind of flea, laid eggs under one's toenails; in time a white sac with black specks appeared, which broke upon the maturity of the embryonic fleas and itched intolerably. The *roncho*, a parasite of the ringworm class, came with the friction of rain-soaked garments, and spread in forms like minute crocus-blossoms all over the body. In-

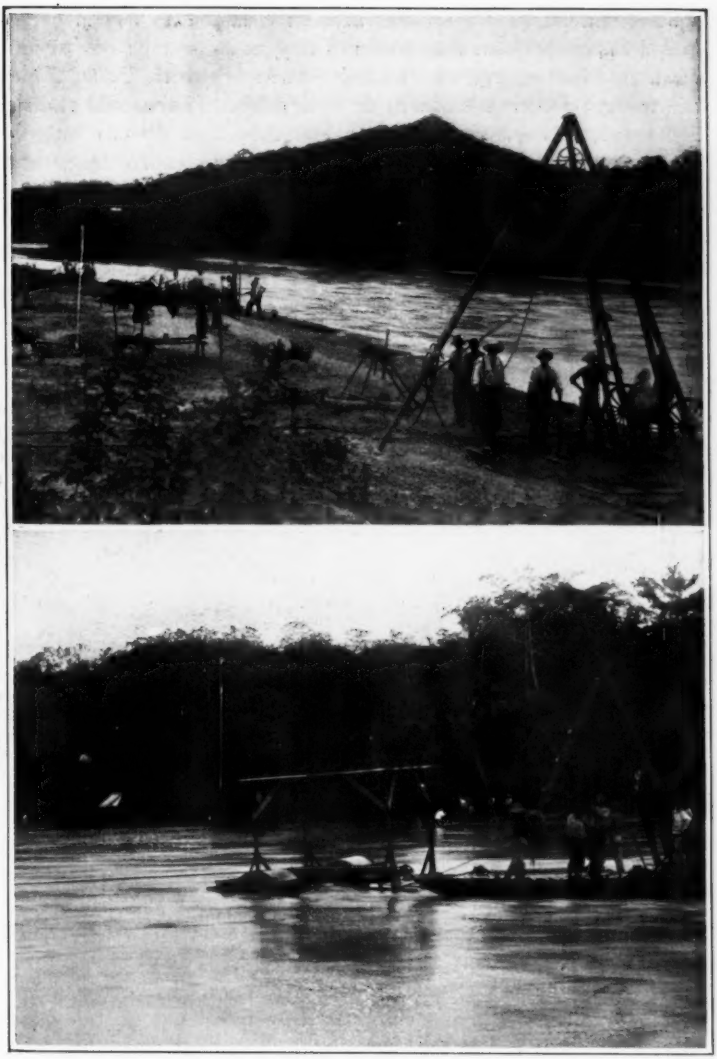
"IN PAJAMAS."

An engineering field party in costume adapted to the climate.

dolent ulcers, induced by poisoned scratches, had to be burnt out with lunar caustic, which meant, of course, lifelong scars. Neither last nor least of the malignant insect parasites was the *gussano,* which when first ensconced looks like a bad boil; if left to mature a worm an inch long is produced, which grows with its head inward (like the intestinal parasites of the hog) and breathes through its tail. It is easy enough for the stay-at-homes and "cabinet surveyors" to belittle the effect of such things on the man in the field; the fact remains, that bad water and bad air and the resultant service conditions of demoralization have been the real causes of failure, hitherto, at Panama.

AN ENGINEER'S CAMP UNDER CANVAS.

The first inland camp of the Ehle party was established on the Chilibre River at the junction of that torrent with its main tributary, the Chilibrillo. The usual procedure in camp-building was to clear a space with *machetes* and erect pole shacks, with forked sticks to support a ridge-pole and vine-lashed rafters, thatched with palm fronds overlapping to a thickness of some four inches. These shacks were open on every side to wind and sun. Provisions came from the Panama Railroad commissary to Bas Obispo, and thence by *cayuca* (canoe) up the Chagres and the Chilibre, the canoes under the skilful management of natives with iron-shod poles. The Chagres was here a beautiful stream, a few hundred feet in width, seeming



MAKING BORINGS TO DETERMINE THE FEASIBILITY OF ERECTING A DAM AT GAMBOA.

The upper view shows a "wash rig" in the foreground and a "pierce rig" in the middle distance. The lower picture illustrates boring in the river from a raft made with old French iron tanks as buoys, to prevent the raft from being pulled under by the high velocities of the Chagres in flood.

little to deserve its evil reputation as its clear waters flowed over a gravel bottom between their banks of clay, at an average rate of four miles an hour—except for swirling corners where the *palunka* men had to fight a current of seven or eight miles. They would steal up like a trout about to take a falls, and then dash directly into the rapids, men at bow and stern holding the boat's course true, until, amid triumphant yells, the strain was slackened on the bending poles and the dug-outs shot into smooth water again.

OBISPO LACK, FROM THE NORTH.
Showing abandoned French machinery on the bank.

Camps were re-established whenever the tramp to and from the site of the day's operations got too long. Along the course of the lower Chilibre, narrow gullies were avoided, since cloud-bursts of rain often turned mere rivulets into roaring torrents. At the third camp at the foot of the Continental Divide, where the Chilibre turns to the west, the party found the river-bed strewn with boulders, sometimes thirty feet in diameter, infested with colonies of bats which fluttered in the faces of the surveyors. The main survey line here crossed the Divide and followed the Lajas valley (a part of the Pacific drainage), the Lajas being a typical mountain stream with steep falls near its source, tamed into a placid current a few miles further on. From the main survey line surveys and reconnaissances were

made over the adjacent country, to determine the shortest crossing for the tunnel spillway. Many of these side-lines were run along the continental backbone to the rocky precipitous mass of the Pico Pinzon, which afforded an eyrie from which to spy out the physiography of the region. The result of all this was the determination of the feasibility of the Gamboa dam, and the location of the eight-mile tunnel spillway line to the Pacific, Mr. Ehle's exhaustive technical description of which will be found in a supplementary appendix at the end of this article.

When Major Black, in behalf of the Commission, took over from the new Panama Canal Company the work of building the Canal, in May, 1904, he found two archaic French excavators fitfully at work; and as the repair shops were either abandoned or dismantled, it was impossible to keep enough cars and engines in commission to handle

CONSTRUCTION RAILROAD BRIDGE ON THE CHAGRES NEAR GAMBOA, OPPOSITE BAS OBISPO.

Built by the French Company, on steel piers, one of which has been washed out and replaced by wooden frame bents and a short suspension span.

even the dirt dug by these two machines. The working force had dwindled to something like 300 men, working 10 hours a day for a stipend of $1.20 in Columbian money—40 cents more than at the low ebb of the French *régime*. With the advent of the Americans, the day's wage mounted to $1.50 in silver. Since May, 1905, the Commission has paid $1.80 and $2.00. The efficiency of the laborer is never more than 30 per cent. of that of the Italian laborer in the United States.

Machine shops were opened at Matachin, and the excavating and traction machinery was overhauled. The excavators are of the endless-chain type, discharging twenty buckets per minute through a chute into 5-yard dump cars. Usually there are twelve cars to a train; on rainy days with wet rails the engines cannot haul more than four. During 1904, these excavators were found to work very well, in the easy digging, but the impression they made on the soil in comparison with the entire mass of earth to be handled, has been dubbed "hen scratches" by an unbiassed observer. The first of a lot of new and large steam excavators got to work in November, 1904.

CULEBRA CUT, FROM THE NORTH END.

One of the old French excavators is seen in the foreground.

At this time the chief executive control was transferred from resident engineer Harper to division engineer W. E. Dauchy, formerly chief engineer of the Rock Island Railroad, a man of extended experience and executive ability. It might be remarked just here, that there appears little justification for the assertion that powerful railroads*

* Wallace, chief engineer; Dauchy, division engineer; Karner, resident engineer, had been more or less closely affiliated with railroads. Of the resident engineers, Ehle, Dose, List and Harper were from general, army, or city practice. Assistant engineers Nichols and Ruggles were from general practice. Quartermaster King is from the army; paymasters Toby and Shaefer are from the navy. Col. Gorgas and Major Lyster are from the army medical corps; Governor Magoon is from private life. Messrs. Ehle, Dose, and Nichols selected the members of the first engineering corps. After September, 1904, the selection was made by the Civil Service Commission.

have secured the appointment of railroad men to all the important positions at Panama. Two or three instances of railroad men being appointed, for their demonstrated engineering ability, do not warrant the sweeping deduction. It is, however, increasingly evident that enough army officers have been appointed to positions where engineering skill combined with infinite administrative tact is needed.

Mr. Dauchy, upon his appointment, did his expeditious best to forward the work of excavation and to determine the lowest yardage price, in order to afford the chief engineer a reliable basis for contracts, and for calculating ultimate expenditures. In the fall—the rainy season—of 1904, there were disastrous slides from Gold Hill,

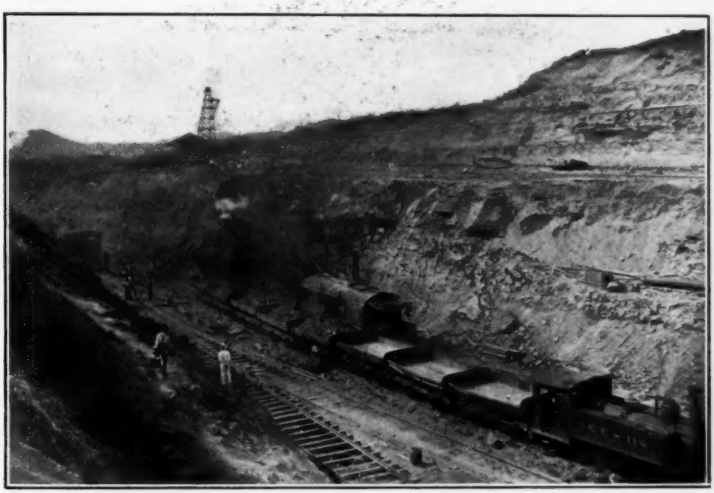
SOUTH END OF THE CULEBRA CUT.

to the west of the Canal; the railway tracks were covered with clay, and work was necessarily suspended for more than a month. During the succeeding dry season, more shovels were put to work on the clay surface stratum, in the hope of avoiding a similar catastrophe in the rainy season of 1905. These shovels, 75- and 90-ton, the latter having a 5-yard bucket, made a good record in spite of inadequate traction and dumping facilities. The track was an unballasted, undrained makeshift, with sleepers of soft pine, and a slight rain sufficed to demoralize traffic. The high, narrow-base French rail was used, with 4-inch spikes; the insufficient length of the spikes was due to a failure to specify any particular length in ordering.

FRENCH EXCAVATORS AND AMERICAN STEAM SHOVELS AT WORK AT CULEBRA.

The upper picture shows the French chain-and-bucket machines Nos. 50 and 52; the lower shows the American shovels 101 and 102, in the 90-metre level.

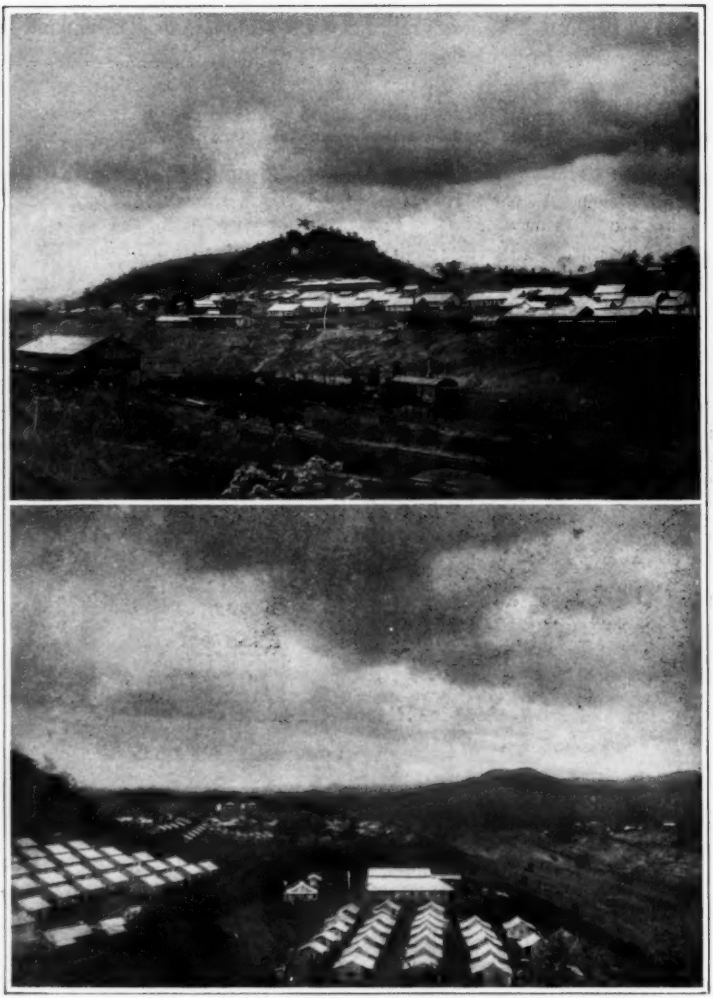
The Belgian locomotives were ill-adapted to such a track, and sometimes, despite the frequent rail braces, sixty or seventy yards of rail would "turn turtle," derailing the excavating trains. Frequently the excavators had to shut down while the trains were jacked up and the track repaired, with bits of rail and scrap-iron in lieu of re-railing frogs and the heavy jacks which should have been provided. This sometimes took three days. "Probably the most serious detriment to progress," said one of the resident engineers to the writer, "was the delay, through red-tape, in getting equipment and supplies; for in spite of hurry orders, begging, and protests, no track tools, such as spikes, mauls, ratchet lining-bars, and track wrenches, were



SHOVEL "NO. 201" AT THE BOTTOM OF THE CULEBRA CUT.

sent. Rails when cut could not be drilled for the bolts, and these half-bolted joints were the cause of many bad derailments. Men lining track had to go off and cut poles, or pick up old lining rods. Track jacks were scarce as hen's teeth. A few were resurrected from the French scrap piles and made serviceable for a while, but as they were badly rusted their life was short. Serious delays to the steam shovels working on rock faces at Culebra were caused by poor mining equipment. All that was available was inherited from the French, and was about at the limit of its effectiveness.

"Most of the work on the soft rock was done by the negroes with long juniper rods. Steam drills had to be used on the hard rock, but



GENERAL PANORAMA OF THE CULEBRA CUT, FROM OPPOSITE SIDES.

Both views show the camp. In the upper one a newly arrived shovel is seen in course of erection.

progress was very slow, and as it seemed impossible to get men to work at night, the steam shovel at a rock face was not very effective. The French had originally laid out their work in 5-metre benches, using the excavators, but for the steam shovel usually two of these were cut into one, so that the face was about 35 feet, except for the shovels on the top levels in clay, where it was often double the height.

"This overlying clay was full of springs, and often slid, burying the jack-arms of the shovels, but causing no serious trouble. At the bottom of the cut the French had left cross-over places, about every half-mile between the two sides of the cut, for their train-service. These had drainage openings through them and connected with the tunnel at the south end of the cut. This tunnel was built with iron-arched forms lagged with wood, and as this decayed it filled up so that the lower levels of this cut were drowned out and a fine lake was formed, cutting off all track communication, until it leaked away at a very slow rate with the coming of the dry season and less rain. In spite of this lesson, no attempt was made to provide against a repetition of the trouble in the wet season of 1905, until in May, when there was a feverish rush to cut the barrier at the south end. During the dry months from December, 1904, to May, 1905, everything was sacrificed to making a record for yardage and cost.

"For these months the cost as estimated was generally below 50 cents per yard. Such estimates were, however, largely a matter of book-keeping, and this fact had to be known to form any clear idea of the subject. With the coming of the wet season in May, yardage began to decrease and expenses increased so that the cost doubled. The large force was being rapidly increased, and the results decreased, until in July and August the work was practically at a standstill."

On his return from the Isthmus in August, Chairman Shonts of the Commission said that the digging had been stopped; General Hains and Mr. Ernst of the Commission are reported as saying there will be no further excavation for about a year. The halt has been called in order that the necessary preliminary work of sanitation may be done, similar to Colonel Waring's work at Havana; that malaria and yellow fever may be checked, if not abolished, by the eradication of the breeding-places of the mosquito; that an abundant supply of pure drinking water may be provided; that adequate shelter may be erected for the Canal employees. This is just what Mr. Morison said must be done in advance of any digging, and probably it will take at least the two years he postulated. It was a grave ad-

ministrative mistake, therefore, to send to the Isthmus quantities of tools and equipment at this stage of the game, at the same time denying to the handful of men at work in the field the machinery and implements they imperatively needed.

It is often asked what proportion of the canal work has been done, but there has not yet been any decision as to the type of canal. However, the question may be answered in a general way. The total yardage excavated on the Panama Canal to date, of every character, is about 79,000,000 cubic yards. Much of this was thrown out by the present plans, and the new French Company admit that the Chagres has silted in 5,000,000 cubic yards, and the Rio Grande at the Pacific end 2,000,000. Also, much of the canal excavation was deposited too close to the cut, so that with the larger-sized canal now planned it has to be handled again.

Taking the Isthmian Canal Commission (1900-01) estimates of useful work as a basis up to 1902, the yardage of the present canal excavated would be in round numbers 41,000,000, so that for the various plans suggested the following approximate parts of the canal excavation are done:—

I. C. C. plan, 1901-2	about	28	per cent.
60-foot level plan, I. C. C., 1904	"	23	" "
30- " " " " "	"	19	" "
Sea-level " " "	"	16	" "

Of course this does not represent the whole work, since the dams, locks, breakwaters, etc., are not allowed for in the above percentages. Including these, the proportions would be about as follows:—

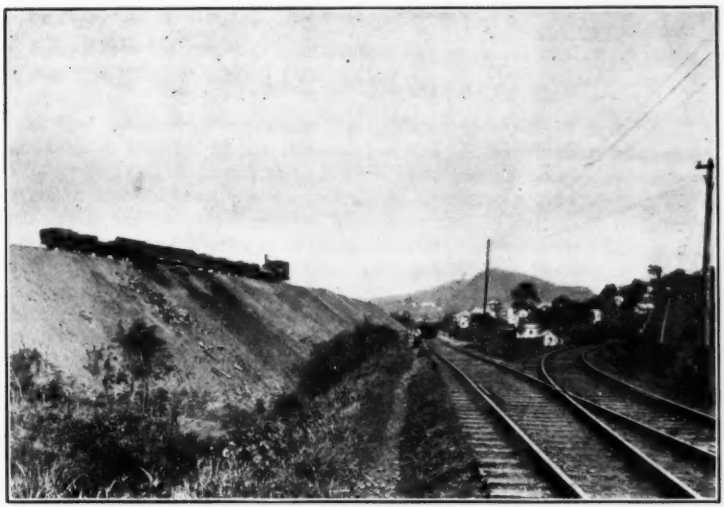
	Per cent.	
I. C. C. (80-foot level) plan, 1901-2	about 23½	(about 1/4)
" (60- " ") " 1904	" 16½	(" 1/6)
" (30- " ") " "	" 14½	(" 1/7)
" (sea- ") " "	" 13½	(" 1/8)

And this small percentage represents nearly a quarter of a century that the work has been nominally under construction.

The question naturally follows, when can the canal be completed? Chief Engineer Wallace, during his early experience on the Isthmus, estimated under the most favorable conditions:—

For sea-level plan	12 years.
" 30-foot level plan	10 "
" 60- " " "	8 "

This would be a fair estimate, for the work *could* be done in the United States under good contractors; but if we apply to this estimate



A HIGH SPOIL BANK NEAR CULEBRA.

The disposal of the material removed from the huge cut is a problem co-ordinate with that of excavation. The Gamboa dam, of which the data are given in the following Appendix drawn from Mr. Ehle's report, is there proposed as affording opportunity in its construction for disposing of a large part of the spoil.

the usual 50-per-cent. coefficient of inertia of tropical work due to labor and climate, that has been the fixed experience of many good engineers, it may be estimated with a certain measure of reliability that to complete the sea-level plan would take 16 years, the 30-foot level 15 years, the 60-foot level 12 years. The old French Company did well, excavating 70,000,000 yards, and the above number of years would be roughly at their best efficiency rate, which it will be difficult to beat, as they did mostly easy digging. A more accurate estimate, perhaps, would give: Sea-level, 15 years (until 1921); 30-foot level, 13½ years (until 1919½); 60-foot level, 12 years (until 1918). Of course with much red tape and bad management it may take longer. The sea-level plan (Wallace's estimate) will cost $230,475,725; the 30-foot level $194,213,406; the 60-foot level $178,013,406. The Isthmian Canal Commission report gives the cost of the 80-foot level plan at $144,233,000. It must be understood that as the work goes deeper it is more difficult to handle, on account of less accessible dumps, more troubles from water, and other causes.

APPENDIX.

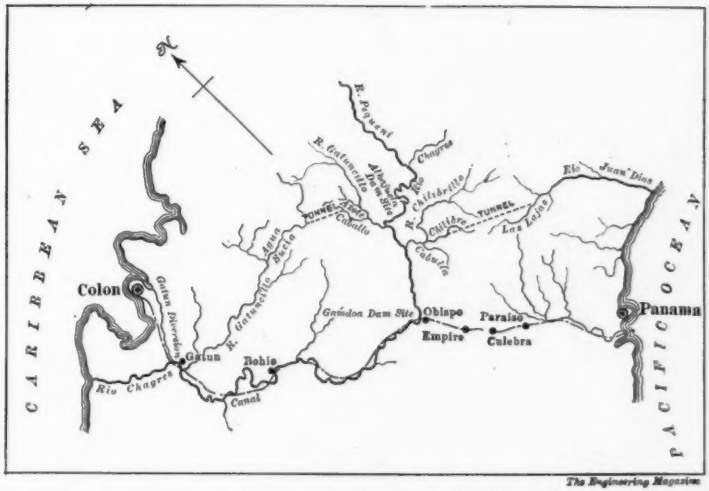
MR. EHLE'S ESTIMATES FOR THE GAMBOA DAM, AND THE TWO SPILLWAYS.

I. The Spillway Design.

The matter of diverging the Chagres floods above Gamboa has now been investigated quite thoroughly, and the data can now be assumed to introduce no considerable error in projecting the following structures.

In determining the location of the wasteway it may be of importance finally to make an adjustment between the cost of lowering the tunnel and raising the dam a unit, but on account of peculiar conditions for building the dam at Gamboa with cheap material from the Culebra cut, this would tend to give too great a height as a structure. There also enters as a factor in the problem the complex requirements for the floods, which are largely matters admitting of little refinement and requiring a considerable margin of safety, but nothing is gained by going beyond the limit in storage capacity, except for industrial uses. From the natural features it was decided that the limiting height for a dam at the Gamboa site should not exceed elevation 200 feet, and this design was used in connection with the preliminary scheme outlined in the September (1904) report with the incomplete data of that date. In this, the top of the tunnel was placed at elevation 175 feet, with the bottom at 145 feet, as the best adjustment to fit the conditions then known, giving a tunnel length of 41,000 feet (7¾ miles) for the Pacific and 23,000 feet (4 1/3 miles) through the Gatuncillo divide, using the Quebrancha location. Since then the surveys have shown that there is a much shorter location by the Azote Caballo branch of the upper Gatuncillo, giving a tunnel length of about 18,000 feet, and that it can be placed at a lower elevation, about 15 feet, without excessive additional cost. That is, the portal cut of the open excavation need not exceed 35 feet at the intake and run out in about half a mile, while at the outflow end in the Agua Sucia, the cut at the river need not exceed 30 feet. A location is now being made across this line. While the results are accurate enough from the preliminary surveys, there may be a variation of one per cent. in the tunnel length. Nothing can be definite about the character of the rock until after the borings, but the surface indications are favorable. In the hydraulic requirements for the discharge of the great floods, a concrete-lined tunnel has been designed with a segmental arch roof of 28 feet span with a rise of about ¼ and a clear height from the invert of 28 feet.

The hydraulic data are as follows:—Area 707 square feet, wetted perimeter 99.5 feet, hydraulic radius 7.1. From this section a tunnel discharging capacity and rate of flow is shown by a graphical chart at ordinary lake level (elev. 160 ft.) as 6,200 sec. feet, and after a raise similar to the 1879 flood (elev. 176.5 ft.) 10,200 sec. feet. These are computed from the formula $V = C\sqrt{RS}$, using the coefficient .012 in Kutter's formula as an average for the concrete lining and with a tunnel gradient .000435. This was designed as the smallest that could give a proper margin of safety in discharging the great floods when placed with the grade at elevation 147 feet and the top of the dam at elevation 200 feet. With the grade of this spillway at 132 feet, the maximum flood elevation would reach 176.5, or 23.5 feet below the crest of the dam, so that it would be possible to make a lower and therefore somewhat safer dam, or



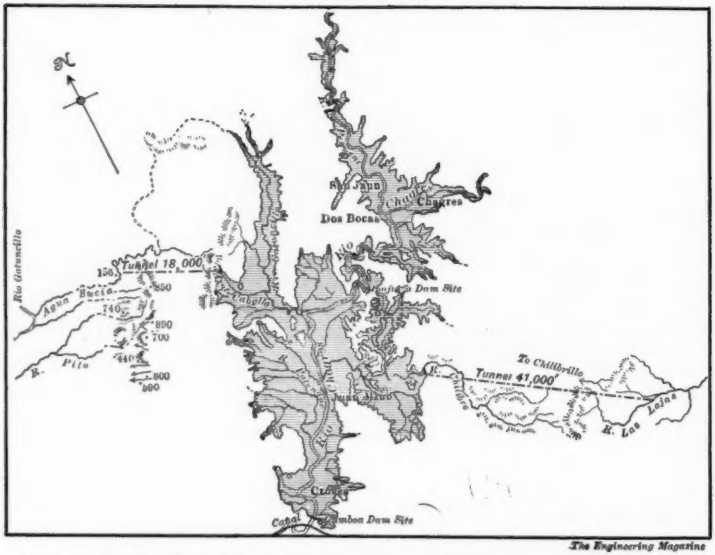
GENERAL MAP SHOWING WATERWAY SURVEYS IN RELATION TO THE PANAMA CANAL AND THE TWO OCEANS.

Scale 1 in. to 9 miles, very nearly.

there might be some saving in the open-cut excavation at the ends of the tunnel, although this enters with comparatively small weight as affecting the Gatuncillo location, and it would not be necessary to cut down to grade as the valleys at the portals are wide enough to carry off the discharge with a less cut at the portal.

The Gatuncillo site is very favorable for regulating works, which would probably be a combination of Stoney gates and valve openings at various levels in a gate house, so that the flow into the tunnel would be under complete control. If the almost impossible contingency, a cave-in in the tunnel, did occur in the wet season in a flood, it would be possible to cut off the flow and store in the reservoir and rely on the gates at the dam to handle the flow while workmen entered and made repairs. For the dam at elevation 200 feet, assuming the lake level safe at 8 feet lower, the storage capacity of the basin above elevation 176.5 at the end of the great flood to 192, or 15.5 feet, would be about 16,120,000,000 cubic feet, which would hold the very high rate of inflow, 11,000 sec. feet, of the wettest season, for about 23½ days with no assistance, except the overflow of 300 second feet of the power plant. As will be seen later on, abundant wasteway gates will be provided at the dam, so that no such necessity can occur. This will indicate the ample provision and resources that are possible in providing for extreme improbabilities.

While fixing the grade of the Gatuncillo tunnel for the portal at 132, or 15 feet lower than the scheme of the September (1904) report, does not materially affect the cost, it is not so favorable for the Pacific wasteway. It will increase the portal cut at the outflow to nearly 80 feet; or rather, lengthen the tunnel about ¼ of a mile, making a total length of 8 miles, and then it would take over 7,000 feet of open cut to get down the valley to the grade; for the



MAP SHOWING AREA OF THE LAKE WHICH WOULD BE IMPOUNDED BY THE GAMBOA DAM, AND THE PROPOSED TUNNEL SPILLWAYS.

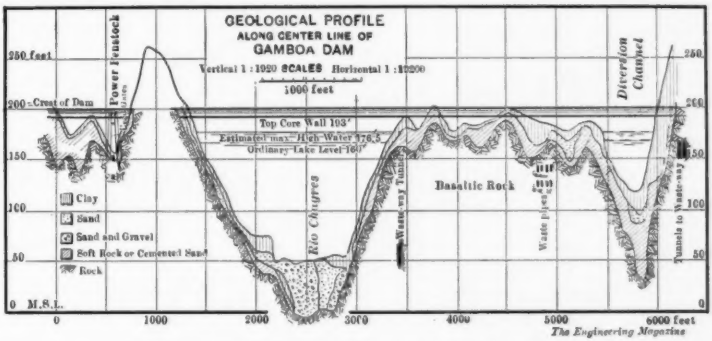
Lajas valley is quite flat at this point. At the intake portal on the Chilibre the change would not cause any noticeable increase in cost.

With the Gatuncillo wasteway, the water goes into the lower Gatuncillo drainage through the Agua Sucia branch, and this drainage will be diverted into Manzanillo Bay through a diversion channel now nearly completed by the French company. As the Gatuncillo wasteway discharge will require about 25 per cent. additional capacity in this channel, it is feared that the pro rata cost for capacity should be charged to the wasteway project. What completetion of the work may cost can only be guessed at, as the data are not yet available, but $1,000,000 may cover it, and of this $250,000, or 25 per cent., is charged to the wasteway for comparison purposes. The channel is purely dredge work, starting from the village of lower Gatun. The lower Gatuncillo has a wide valley for a considerable distance up stream, so that it will not be much affected by the additional water spilled into it, not as a flood but as a steady flow, probably never exceeding 10,000 second feet and generally much less.

In constructing the wasteway, it would be necessary to make some roads for carting in tools and supplies, and some temporary dams might be put in the Gatuncillo to make ponds in low water, but the Chagres is navigable at all times with canoes. It might also be possible to arrange the work so that the back water from the dam would be available. No special charge has been made for these items, as they are small and covered by the contingency percentage.

II. The Gamboa Dam.

This should be a reservoir dam, on account of the natural conditions, nearness to the canal, and economy of time and cost. The design that seems most advisable to submit has an elevation of 200 feet at crest, which may be a trifle higher than necessary, as it gives a freeboard of 23.5 feet with the greatest flood; and an estimate has been made for the crest elevation 185 feet, giving a freeboard of 8.5 feet or about the usual amount. The difference in cost is about one half million dollars, but probably it would be as well to pay the difference as an insurance for a safer dam. There is so much available cheap material for embankment that it probably will be decided to make a greater fill than indicated by the neat lines shown for the section, which has a crest width of 20 feet and a slope 1 on 2, with a core wall founded in rock 30 feet wide up to elevation 70 feet and then sloping 1 on 10 to 5 feet at the top, elevation 193 feet. The embankment is to be made from the débris of the Culebra cut, dumped from trestles or aërial cableways as are best adapted. It probably will not be necessary to make any special provision for paving, as the larger pieces of quarried rock can serve for this. As one of the difficulties of the great excavation is sufficient and convenient dumps, it is taken that the charge for material would be nominal, mostly due to the cost of dumping, with perhaps a percentage of the transportation charges. The total average per yard need not exceed five cents.



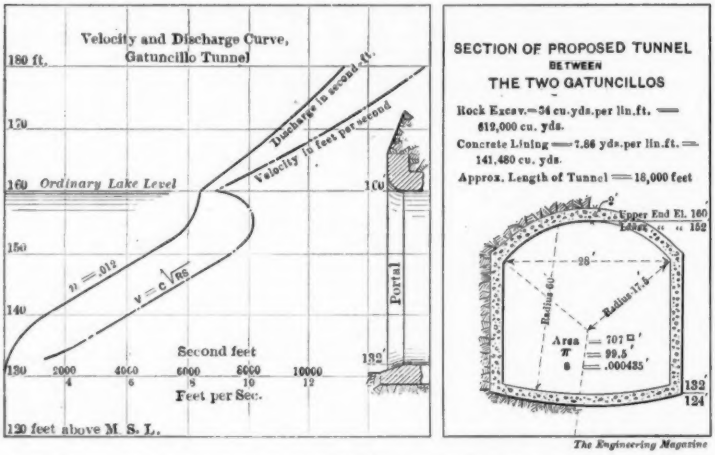
GEOLOGICAL PROFILE ALONG CENTER LINE OF GAMBOA DAM.

From the data now available it does not appear that any exceptional difficulties need be apprehended in construction, as the site is well adapted for such work and the maximum depth to rock is about 52 feet below low water. The core wall construction can probably be built in coffer dam by sections with little difficulty. It was assumed that the core wall would have foundation 10 feet below the surface of the material noted as soft rock on the profile and that probably would be leveled with light cutting in the hard basaltic rock.

In the dam at the saddle at the South end, have been placed the head gates of a power plant with tunnel intakes at various elevations. In the hill which forms the north buttress of the main dam, is placed the gate tower for emptying the reservoir with low tunnel intake, placed with two gates each at

elevation 44 feet, 75 feet, and 100 feet. From the wall a large tunnel goes through the solid rock to below the toe of the dam.

At a point farther along the dam and near the old spillway are placed waste pipes at elevation 132 and 142 feet, of a total capacity equal to the tunnel wasteway and, in connection with the tunnel and weir on the north end of the dam; to do its work, if the very improbable cave-in should occur during the flood season. In the spillway is placed a dam for making a lake at about elevation 125 feet, to act as a cushion to take up as much as possible the effect of dropping the water 50 or 60 feet to this level. A gate house is provided for the pipes on the north side of the ridge near the pond, and the pipes are designed to have about 25-feet back pressure, by discharging upward to facilitate opening the gates and also to have a vertical fall of the water.



SECTION OF PROPOSED GATUNCILLO SPILLWAY TUNNEL, WITH VELOCITY AND DISCHARGE CURVE.

The tunnel and weir in the hill at the north end of the spillway is designed for Stoney gates with sill at elevation 150 feet. The weir is to discharge along the side of the channel in a thin sheet of water down into the pond. The toe of the dam at the pond is to be protected by a concrete wall.

The dam that makes the pond is to be a concrete weir, and there is also an opportunity to make a similar shorter weir by excavating a channel in the creek that discharges into the Chagres near the toe of the main dam; but this water would come more directly to the canal. After the water flows over the weir it would pass down to the diversion channel along the Canal, and it may be advisable to place some weirs below to check the current. Their cost would be but a small percentage of the total for the whole project, and comes properly under diversion channels, as the water is then clear at the dam. It is to be noted that the dam now submitted is not on the same location as that of the September (1904) report, but is swung down stream at the north end of the river crossing, to take advantage of the narrowing in the rock channel, a shorter distance below the first site, as shown by the later borings.

Estimate of Gatuncillo Spillway.

612,000 cu. yds. rock excavation in tunnel @ $4.00	$2,448,000
141,480 cu. yds. concrete lining @ $10.00	1,414,800
500 linear feet of shaft @ $50.00	25,000
190,000 cu. yds. rock excavation @ $1.15	218,500
50,000 cu. yds. earth excavation @ $0.50	25,000
Controlling works at intake (about)	40,020
Proportion in diversion channel at lower Gatun to Manzanillo Bay	250,000
Total (about)	$4,421,320

Estimate of Pacific Spillway.

1,436,160 cu. yds. rock excavation in tunnel @ $4.00	$5,744,640
332,000 cu. yds. concrete lining @ $10.00	3,320,000
500 linear feet of shaft @ $50.00	25,000
300,000 cu. yds. rock excavation @ $1.15	345,000
Controlling works at intake (about)	55,360
Total (about)	$9,490,000

Estimate Gamboa Dam.

Crest at 200 feet elevation, length on crest about 5,700 feet:—

2,700,500 cubic yards embankment @ $00.05	$135,025
259,400 cubic yards concrete @ $8.00	2,075,200
Excavation for core wall:—	
104,300 cubic yards earth excavation below river level @ $1.00	104,300
90,000 cubic yards earth excavation @ 0.75	67,500
28,600 cubic yards rock excavation (mostly soft rock) @ $1.25	35,750
	$2,417,775

Difference for Dam at elevation 185 feet, length on crest about 4,230 feet.

648,000 less cubic yards embankment @ $00.05	$32,400
65,900 " " " core wall @ $8.00	527,200
19,000 " " " earth excavation @ $00.75	14,250
6,000 " " " rock " @ $1.25	7,500
	$581,350
Cost of Dam at elevation 185 feet	$1,836,425

If we add 20 per cent. for engineering work and contingencies, the estimate would be,

For the dam at elevation 200 feet	$2,901,330
For the dam at elevation 185 feet	$2,203,710

"It is noted for comparison, that Mr. George S. Morison, past president of the American Society of Civil Engineers and member of the Isthmian Canal Commission of 1899-1900, in a paper in the Transactions American Society of Civil Engineers, gives the cost of the Alhajuela Dam at $3,000,000 plus 20 per cent., or $3,600,000, and that General Abbot's translation of the report of the New French Company gives $2,356,700 plus railroad $312,100, plus proportion of contingencies $36,800, plus $7,600, or a total of about $2,713,200."

THE UTILISATION OF LOW-GRADE FUELS FOR STEAM GENERATION.

By W. Francis Goodrich.

The leading idea in modern industry is the reduction of the cost of production, by the closest study of materials, methods, appliances, and labor. In the steam-generating plant, the chief aim is the economical production of power, and the "raw material" to be studied at the outset is the fuel. Mr. Goodrich therefore begins his study of the problem at its very foundation. The supply of low-grade fuel and its cost necessarily vary considerably in different localities. Mr. Goodrich's study is based upon conditions existing in London, but his deductions may readily be applied or his methods adapted to the situation at other places.—THE EDITORS.

IT is on record that James Watt had a decided preference for the very best fuel procurable, and that on more than one occasion he expressed the opinion that the best fuel was the cheapest in the end, no matter what the price might be.

There can be no doubt that under the conditions obtaining in the early days of steam generation, the opinion expressed by James Watt and others was perfectly logical. The combustion process, even now but imperfectly understood, was at that time a matter of no interest whatever; but now, eighty-six years after James Watt has been laid to rest, it ill becomes the steam user to re-echo his opinion; indeed, nothing could more strikingly illustrate the appalling ignorance which is only too prevalent among steam users at this time.

The life-long labor of Watt was essentially devoted to steam ***utilisation,*** and not to steam *generation.* When one recalls the great work accomplished by this remarkable Scotsman—his ceaseless industry and dauntless perseverance—it may be well understood why he devoted comparatively little attention to steam generation. Had Watt directed his attention to steam generation rather than its utilisation, the world would have been the poorer today, and it is impossible to realise what the effect would have been upon commercial development.

Even as the steam user of today frequently expresses the same opinion as is attributed to James Watt, so does he to a very large extent follow Watt in devoting an almost undivided attention to the engine; and so we find everywhere large works equipped with the finest engines obtainable, the boiler house to a large extent being

neglected. While the manufacturer is leaving nothing undone in the economic utilisation of the steam, he too often neglects the fountain head—the boiler house. Here, where economy should commence, it is unknown, and the unscientific steam user fails to recognise that the loss in the generation of steam is added loss, which cannot possibly be recouped at any later stage in the manufacturing process, no matter what the particular industry may be.

Those who are intimately acquainted with steam-raising practice in Great Britain (and no doubt elsewhere) will be well aware that this is not overdrawn; the grievous lack of attention given to economy in steam generation has undoubtedly been a serious factor operating against the manufacturer. In the grim commercial struggle, fuel economy is an element which cannot be disregarded, and those who have devoted but little attention to the stoke-hole have often been hard put to it in competition with others who have recognised the wisdom of beginning at the beginning.

In many manufacturing industries it is becoming increasingly evident that the fuel cost is *the* factor which must receive close attention; indeed, in some it may be said to be the vital factor in the cost of production. Those who have achieved the greatest success in every manufacturing industry in which steam is used, are those who have reduced their works administration to the same basis as that obtaining in the central station. The really successful paper maker is he who is able to make each ton of paper at the minimum fuel cost. The wide-awake dyer strives to dye each piece of material at the lowest fuel cost, and so on through each manufacturing industry.

To utilise steam economically as a means to an end is not sufficient in itself, although it has undoubtedly been beneficial even when the boiler house has been neglected. The up-to-date manufacturer will go further than this; he will begin at the right end, putting both steam generation and utilisation upon the most efficient basis, and having done this he has accomplished not a little towards equipping himself for successful competition.

When the manufacturer has reduced his production cost to the minimum he has done his part, and collectively a great deal would thus be accomplished. I do not suggest that every dead industry would be revived, or that every languishing industry would flourish; much might still remain to be done; but having helped himself, the steam user might then reasonably look for help.

Why legislate for those who have not and will not help themselves? Why protect those who to a large extent have failed to com-

pete because they have been content to conduct their works as their forebears did? We have many such as these in the country; to legislate for their benefit may restore some of them to their erstwhile prosperous state, but from a National standpoint such assistance is to be deplored.

The main object of this article is to show (1) that the utilisation of low-grade fuels does materially reduce the cost of steam generation, and accordingly the cost of production; and (2) how such low-grade and cheap fuels may be best utilised for steam generation.

Taking the whole of the circumstances into consideration, is it economical to burn cheap or low-grade fuels, or does the opinion expressed by James Watt over a century since still hold good?

It must be borne in mind that when Watt commenced to use steam in Cornwall—and in fact, during the whole of the time that he labored in the "Delectable Duchy"—ordinary natural-draught boiler furnaces of the crudest description were used. Watt was content even without a fire door, the mouth of the furnace being closed by merely heaping up coal on the deadplate, there to lie until pushed forward when recharging the furnace.

It is easy to understand why the best fuel was the cheapest at this time; indeed, there was no choice; nothing but the best fuel could be burned under the conditions then obtaining. From this time forward, and even until a period only about thirty years since, little attention was devoted to fuel economy.

Whether it is economical to burn cheap or low-grade fuels depends entirely upon certain specific conditions which we will briefly discuss.

(1) The cost of good steam coal, and its calorific value.

(2) The comparative cost of small and lower-grade fuels and their calorific values.

(3) Whether or not the cheaper fuels are burned under such conditions as will ensure that the full calorific value of the cheaper fuel shall be realised.

For purposes of argument, we will assume that the best Welsh steam coal, having an average calorific value of 14,500 British thermal units, can be obtained in London at about 21 shillings per ton delivered. Then for purposes of comparison I would set against this a bituminous slack fuel costing about 12 shillings 6 pence per ton delivered, and having a calorific value of 12,500 British thermal units. London is selected purposely because the freight charges on any fuel are high and because it has been frequently urged that with this

factor in mind it does not pay to burn "so-called cheap fuels" in London.

Without entering into any calculation, mysterious or otherwise, it must be evident to anyone that the extra weight of bituminous slack which must be burned in order to evaporate the same weight of water as is possible with the Welsh coal is very materially less than the comparative cost of the two fuels.

About a year since I conducted an evaporative test in London with a bituminous slack fuel having a calorific value of 13,007 British thermal units, costing 12 shillings per ton delivered, the average evaporation over the whole week being 8.82 pounds of water per pound of fuel burned from and at 212 degrees F.

In comparing the actual evaporative efficiency of this fuel with its theoretical thermal value, it will be evident that the results obtained were by no means the best results possible; but it must be borne in mind that the evaporative efficiency given is the average for 168 hours' work, under varying conditions, with several extended periods of very light work. The result quoted was obtained with hand-fired forced-draught furnaces fitted to a large marine-type boiler.

As the result of many experiments the late Mr. Bryan Donkin, M. I. C. E., published the following comparative figures some years since:

Kind of Fuel.	Cost of Fuel per ton.		Water evaporated per lb. of fuel.	Cost of Fuel per 1,000 gallons of water evaporated.	
	s.	d.	lbs.	s.	d.
A. Dust coke	5.	0	6	3.	8
B. Dust (Welsh coal).....	10.	0	8	5.	3
C. Large Welsh coal.....	22.	0	9	10.	11

Those who are intimate with steam-raising practice will be well aware that these figures have been verified again and again over extended periods and under a great variety of working conditions. It may further be submitted that the fuel costs in each case err on the right side. In some large cities, where all coke dust is sold separately at the gas works, this fuel may be obtained at 1 shilling per ton at the works. In South Wales it is also possible to obtain large quantities of dust fuel from Welsh steam coal at from 1 shilling to 2 shillings per ton. A sample of this fuel taken at random and tested was submitted by the writer to the Royal Commission on Coal Supplies; its calorific value was actually 13,646 British thermal units.

It is a common delusion that a small fuel must necessarily be of low calorific value, and accordingly of doubtful economic value even

if it can be burned. As a matter of fact, many small fuels are of excellent calorific value and when burned with suitable appliances will show a phenomenal saving.

Again and again have I seen an evaporation of 10 pounds of water per pound of fuel obtained with slack from Welsh steam coal costing from 5 to 6 shillings per ton less than the large coal. Slack from a good Welsh steam coal is really remarkable value for money as compared with the large coal from which it is separated; generally speaking, 20 tons of such slack will evaporate fully as much water as 19 tons of the large coal, and assuming their respective costs per ton to be 15 shillings and 20 shillings, the saving to the steam user will be the difference in cost between 20 tons at 15 shillings per ton and 19 tons at 20 shillings per ton, say £4.

If we compare an average bituminous slack with an average Welsh steam coal, we get the following result, assuming a calorific value of 7½ pounds of water per pound of fuel for the bituminous slack, and 10 pounds of water per pound of fuel for the Welsh steam coal, their costs respectively being 12 shillings and 20 shillings per ton delivered:—

In order to evaporate the same quantity of water as could be evaporated with 20 tons of Welsh coal, costing £20, 25 tons of bituminous slack at 12 shillings per ton must be burned, costing £15, thus effecting a saving of £5.

These are but fair average examples, and are not overdrawn; they represent what has actually been done in London in scores of cases, and may therefore be accepted as authentic.

It is quite true that other factors have to be taken into account in order to arrive at the *net* economy which can be effected. It may be suggested by the incredulous, for instance, that the extra weight of slack to be burned would necessitate the employment of another fireman at 30 shillings per week; but the wide-awake steam user would offer his firemen a bonus of, say, 2 shillings per man per week; this always has the desired result. Give the firemen a definite interest in the way of some financial encouragement, and no difficulty is presented. On the other hand, if you fail to give those who handle the fuel some direct encouragement it is more than likely that you will fail to secure the economy which you should secure, and like many another steam user you will condemn small cheap fuel as a delusion and a snare.

In many cases where small fuel is burned it is not an easy matter to get rid of the incombustible, and sometimes as much as 2 shillings

per ton is paid for its removal. The steam user who believes in burning the very best fuel obtainable fastens upon this as a powerful argument against the use of cheap fuel; he gravely observes that cheap slack is half rubbish, and that half of it has accordingly to be carted away.

Such a statement as this is by no means uncommon; indeed, it is heard frequently. Needless to add, the man who seriously puts this forward as an objection to the burning of a cheap small fuel is grossly ignorant and knows little or nothing concerning the composition of fuels. This is the type of steam user who has never helped himself, and is never likely to. In the stress of competition, should the State not help him by favorable legislation, while he may lose everything else he will still keep his opinion.

Generally speaking, the percentage of incombustible in bituminous slack and small rough fuels is not high, varying from about 20 per cent. to 9 per cent., according to the price. Reasonable uniformity in calorific value and in the percentage of incombustible matter can be ensured only by buying fuel on analysis, and by systematic testing and analysis of the fuel delivered so that any serious decrease in the calorific value or increase in the percentage of incombustible may at once be detected.

Neither the colliery proprietor nor the coal merchant is particularly anxious to sell fuel on analysis, nor is this to be wondered at. To buy fuel on analysis is to demand from the vendor definite value for money; this the purchaser has a perfect right to do, and the time is rapidly coming when this system of buying fuel will be more or less generally adopted. Those who conduct their works on these lines possess very definite opinions as to the economic value of cheap and low-grade fuels. The scientific application which they have given to the stoke-hole has been profitable to an extent which can be realised only by those who are intimate with modern practice in economic steam generation.

There can be no doubt that the useful and extensive experience which has been gained in the combustion of town's refuse has clearly demonstrated the possibilities of steam generation from the lowest grades of colliery waste. The following table is of interest as showing the composition of several waste fuels, most of which are now being successfully burned for steam generation. I have extracted this table from the minutes of evidence which I gave before the Royal Commissison on Coal Supplies.*

* See Second Report of the Royal Commission on Coal Supplies, 1904, pages 272-278.

TABLE SHOWING ANALYSES OF CERTAIN INFERIOR FUELS.

		Calorific Value.	Volatile Matter. Per cent.	Incombustible. Per cent.	Moisture. Per cent.
Park Coal Co., Mirfield.	Coke dust and coal dust.	10.2	22.96	22.23	....
Nunnery Colliery Co., Sheffield.	Pond settlings from tip.	10.3	27.43	16.06	....
Low Moor Co., Ltd., Bradford.	Tank settlings.	5.75	20.63	20.66	10.5
Aldwarke Main Colliery, Rotherham.	Pickings.	10.8	35.5	24.066	....
Morley Main Colliery Co.	Bottom hub.	7.1	41.6	42.0	....
Nunnery Colliery Co., Sheffield.	Pickings from screens.	8.5	24.075	36.6	....
Nunnery Colliery Co., Sheffield.	Coal washery refuse.	5.1	17.125	54.66	....
Nunnery Colliery Co., Sheffield.	Pickings.	13.0	35.16	9.23	....
Fryston Colliery Co.	Fine washings.	8.19	39.36	38.9	....
New Charlston Colliery, Normanton.	Washery refuse.	10.28	.....	11.3	11.4
New Charlston Colliery, Normanton.	Pond settlings.	12.04	.....	0.78	40.2
Woolley Colliery Co.	Pond settlings.	11.66	21.125	17.4	....
Crawshaw & Warburton, Dewsbury.	Shale.	4.45	27.03	56.63	....
Neepsend Gas Works, Sheffield.	Fine coke dust.	9.4	4.3	13.5	....

It may be of interest to record what has been done with the last-named fuel in the table, viz., fine coke dust (from Neepsend Gas works, Sheffield) as it affords a striking object lesson on the utilisation of a low grade fuel with forced-draught furnaces.

In the boiler house of the Sheffield *Daily Telegraph*, before experimenting with the coke dust referred to in the appended table, 45 tons of coal was burned per week at 12 shillings 6 pence per ton, totalling £28 2. 6. weekly. Seven loads of incombustible had to be carted away at a cost of 2 shillings per load, a total cost of £28 16. 6. One Lancashire boiler only out of two such boilers was

used, the dimensions of the boiler being 24 feet by 8 feet, and much trouble was experienced in preventing smoke.

Having arranged for a supply of the coke dust already referred to in the table, Meldrum forced-draught furnaces were fitted to two Lancashire boilers with the following remarkable reduction in the fuel cost.

Per week.	£.	s.	d.
Six tons of coal at 9 shillings 3 pence	2.	15.	6.
Coke dust	3.	4.	0.
Two extra stokers	2.	12.	0.
Flue cleaning	..	10.	0.
Twelve loads of incombustible	1.	4.	0.
	£10.	5.	6.

With an increased demand for steam, the weekly item for coal increased to £5 3. 2.; and having to work the two Lancashire boilers together in order to burn the requisite quantity of coke dust, it was at length decided to instal a Stirling water-tube boiler with a large grate area, equipped with forced-draught furnaces and patent divided ashpits.

The figures here quoted are extracted from the *Engineer*, January 13, 1905, page 49.

This is a remarkable object lesson in the utilisation of a low-grade fuel, but it is by no means an isolated example. I call to mind many similar cases in Glasgow, some years ago, when the Corporation Gas Department disposed of large quantities of excellent coke breeze at 1 shilling per ton at the gas works. A considerable number of steam users were unable to arrange for regular supplies sufficient to meet their requirements, and cases where a saving in fuel cost of from 50 per cent. to 75 per cent. was effected were quite common.

It is only in large gas works that any considerable surplus of coke breeze is available, and during the past few years (more particularly in London) the price of this fuel has become so high that it is open to serious question whether, considered on the basis of calorific value, it will compare at all favourably with a small bituminous slack fuel.

With coke breeze costing from 8 to 9 shillings per ton delivered, having a calorific value of from 8,000 to 9,500 British thermal units, and a slack fuel costing from 10 shillings 6 pence to 12 shillings 6 pence delivered, possessing a calorific value of from 10,500 to 13,000 British thermal units, all factors being considered, the latter is likely to be the more valuable fuel.

While 1 shilling per ton at the gas works is a ridiculously low price for a coke breeze of fair calorific value, yet is equally true that the price now ruling in London is out of all proportion to the calorific value of the fuel. So far as I have observed, the coke breeze now offering in London varies very considerably in calorific value, and those who have this fuel to dispose of would do well to moderate their prices, or a slump will surely come sooner or later, when the steam user will reap at any rate a temporary harvest.

Pan breeze, which frequently contains 50 per cent. of incombustible, would not appear to be a very promising fuel; but it is nevertheless successfully employed in many gas works for steam generation. It would be idle to pretend that the firemen prefer this fuel to coke, but by treating the men reasonably it is quite possible to burn it when the steam requirements are not excessive.

In the average gas works it is of importance so to utilise the pan breeze and the poorest of the coke breeze, such a course having the effect of leaving free for sale the entire output of coke and practically the whole of the coke breeze produced.

What this means in the economic administration of gas works is clearly evidenced by their universal prosperity, and the practice of utilising the very poorest and unsaleable fuels for power production where they are produced is an object lesson which might be studied with advantage by many collieries.

The utilisation of these low-grade fuels in gas works has been effected by the installation of forced-draught furnaces, and there are now but comparatively few gas works where such furnaces are not in use.

Needless to add the steam requirements in the average gas works are not severe, or it would not be possible, without multiplying the number of boilers, to use such a fuel as pan breeze with internally fired boilers. The consideration of the type of furnace best employed in the combustion of this and other low-grade fuels, and of the possible utilisation of shale, town refuse, and similar lowly and little appreciated supplies of combustible, is, however, of necessity deferred until a following article.

THE VARIOUS METHODS OF GOVERNING FOUR-CYCLE GAS ENGINES.

By R. Mathot.

The constantly increasing use of the internal-combustion motor, in the very largest as well as small and medium sizes, makes it unnecessary to point out further the interest and importance of Mr. Mathot's subject. He is one of the leading experts in this field on the Continent, and the author of several standard treatises on gas-engine design, construction, and operation.—The Editors.

WHATEVER may be the arrangement of the parts of a gas-engine, the dimensions of the latter are calculated so that a maximum moving force can be realized, on the supposition that each one of the valves admits the necessary quantity of gas or air to produce a homogeneous mixture which is capable of giving, by its explosion and expansion, the greatest possible mean pressure on the piston.

This mean pressure is quite variable and depends on the type of machine, the kind and time of ignition, the proportions and elements of the mixture, and finally on the calorific power of the gas used.

It varies generally between 4.5 and 5.5 kilogrammes per square centimetre (60-80 pounds per square inch) for engines using poor gas, and between 5.5 and 7 kilogrammes per square centimetre (80-100 pounds per square inch) for engines using city gas. I have however met cases in which the mean pressure reached 6-6.5 kilogrammes per square centimetre (85-92.5 pounds per square inch) with poor gas and 7.5-8 kilogrammes per square centimetre (107-114 pounds per square inch) with city gas.

When an explosion occurs at each cycle, the engine whose piston is put into motion by the mean pressure mentioned realizes its maximum power. If the work absorbed by the machines that are run by the engine corresponds exactly to the power of the latter, its speed will not tend to accelerate. But if, on the contrary, the resistance of the machines diminishes and the power developed by the engine is no longer exactly counterbalanced by an equivalent load, the speed tends to increase. At this point the governor intervenes and modifies the speed conditions of the engine, so as to maintain it within the normal speed limits.

We propose now to examine the modes of action of the various governors most generally used to regulate internal-combustion engines.

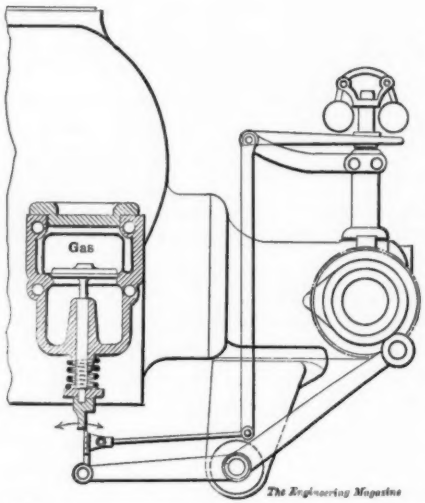


FIG. 1. CENTRIFUGAL GOVERNOR, HIT-OR-MISS TYPE.

The first designers had observed that the practical limits between which the proportions of gas and air in a mixture could be varied, so as still to obtain ignition, were rather narrow; the more so, as the engines operated at relatively low pressures. Also the attempts that were made at the outset to employ contrivances by means of which the proportions could be varied, did not have great success. Moreover, proceeding in this mode, a quite noticeable increase in the gas consumption was very soon observed. Hence it was quite natural to search for a combination by means of which the gas could be completely cut off at a given moment and so cause a "miss." The governing system obtained thus was called "hit-and-miss" regulation. In this system the opening of the gas inlet valve depends on the action of the governor, while the air admission

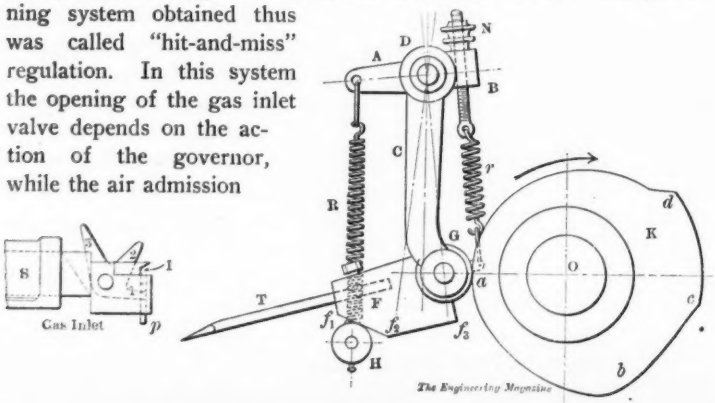


FIG. 2. INERTIA GOVERNOR, HIT-AND-MISS TYPE.

remains independent and occurs at each cycle. As a consequence the number of admissions of the mixture, and therefore the number of explosions, varies as the work of the engine, while the value or composition of each charge admitted, as well as the compression itself, remains constant.

This procedure thus furnishes the possibility of governing, once for all, the quality of the mixture and the conditions under which it acts in the cylinder, so as to obtain the maximum useful work, even if the engine is not working under full load. This method of governing has been for many years considered the most economical.

As shown on page 356, the function of the governor is to displace a light piece which is inserted between the support of the gas inlet valve and the cam. The opening or non-opening of the valve depends on the interposition or non-interposition of this piece. The governor, having no work to overcome, may be a very small and unobstructive piece of apparatus. The small motion of its moving parts causes but little wear and assures perfect isochronism.

This system of admitting by hit-and-miss carries with it the inconvenience of the "misses"—that is, under the action of the regulator several cycles may succeed each other without explosions. This inconvenience would show itself immediately by a retardation of the speed of the engine, if the precaution were not taken of providing it with a very heavy flywheel, or one of great diameter, which during the "misses" restores the surplus energy accumulated during the explosions.

The great weight of these flywheels evidently reduces the mechanical output of the engine, and the difference in output between engines having normal flywheels and those having extra heavy ones may be estimated at about from 3 to 5 per cent.

The use of extra heavy flywheels must, in my opinion, be considered rather as a subterfuge than as a mechanical means to remedy the difficulty, and experience seems to demonstrate that there might be a certain danger in using heavy flywheels, when the power of the engine passes a certain limit. In fact, with hit-and-miss regulation, there will occur after several "misses," a powerful explosion corresponding to a pressure of 30 to 35 kilogrammes per square centimetre (430-500 pounds per square inch) on the piston. This pressure is transmitted to the crankshaft and to the flywheel whose speed has diminished on account of the misses, and therefore considerable torsion (which may result in breakage) is produced in the crankshaft.

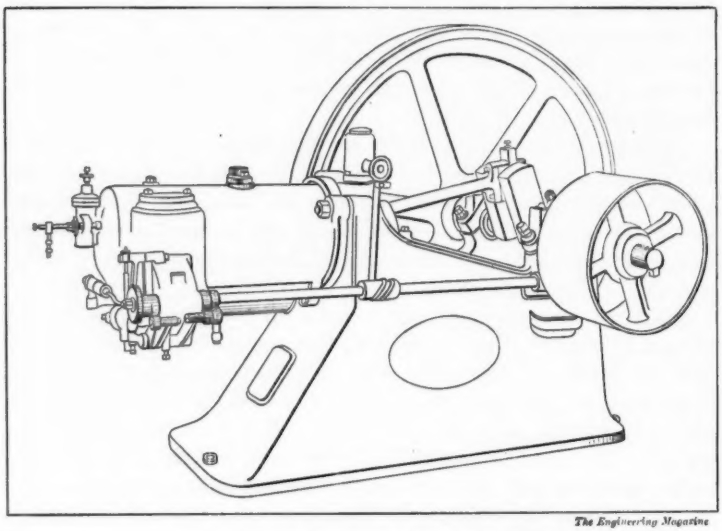


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FIG. 3. ENGINE WITH ORDINARY FLY-WHEEL.

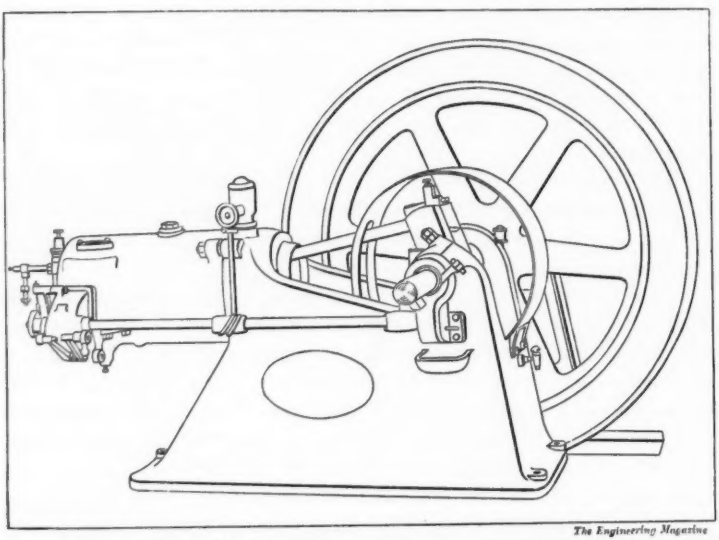

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FIG. 4. HIT-OR-MISS GOVERNED ENGINE WITH HEAVY FLY-WHEEL.

Nevertheless, the system of governing by hit-and-miss is still applied by most English designers, while all German designers have sought the solution of the problem in a different direction.

They made the governor act on the gas mixture in such a way that, according to the power which the engine was called upon to develop, there was produced:—

(I) A mixture of variable quality and constant quantity.

(II) A mixture of constant quality and variable quantity.

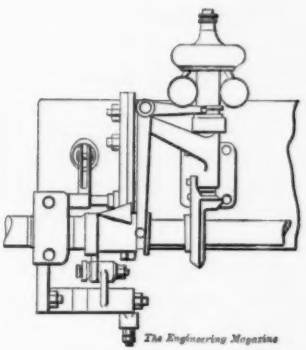

FIG. 5. REGULATOR FOR VARIABLE ADMISSION OF GAS.

Mixture of Variable Quality and Constant Quantity.—The governing device most generally used to obtain this mixture controls the gas-admission valve, through the interposition of a cam having a longitudinal conical section. This cam (called "conical cam") is connected to a lever depending from the governor, which according to its oscillations displaces the cam longitudinally on the cam shaft of the engine.

The result is variation in the duration and amplitude of the opening of the gas-inlet valve.

Another system consists of inserting, between the mixing chamber and the gas inlet, a circular slide having the same axis as the gas-mixing valve proper. The motion of this valve is controlled by the governor, so that the lat-

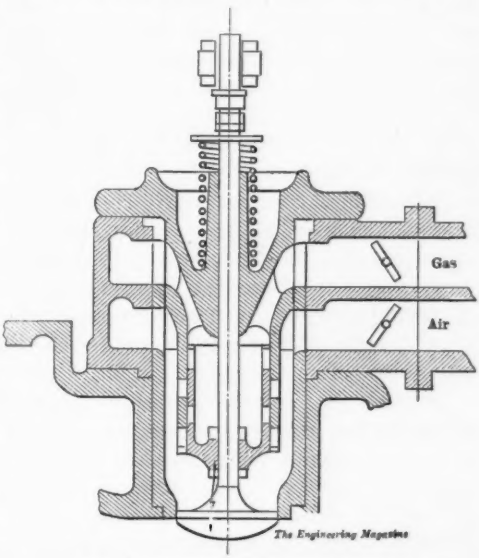

FIG. 6. MIXTURE REGULATING VALVE.

ter varies the quantity of gas in connection with the amount of air. It is worth mentioning that for engines working with poor gas it is frequently necessary to inspect and clean the parts of the two mechanisms just referred to, as they will get greasy very rapidly.

These mechanisms present certain difficulties:—

When the engine works under a light load, the gas valve opens so little that the actual quantity of gas admitted becomes so small in proportion to the air contained in the mixture that it will be very difficult to make the mixture explode. In order to obviate this defect, compression has been increased to 14-15 kilogrammes per square centimetre (200-213 pounds per square inch). With such high compression, very poor mixtures can be ignited; but when, on account of an increased load upon the engine, the mixture becomes richer, the ignition tends to occur very early, and may even happen before the crank has arrived at the inner dead center. This is what is called a premature explosion, and may cause a decrease in the speed of the engine and even stop it. What is more serious, however, is that it may cause the breakage of the crank shaft if the engine is of a powerful type.

Several designers, who have pushed the compression to about 15 kilogrammes per square centimetre (213 pounds per square inch) had to cool the cylinder and its valve or head end very energetically by means of an abundant water circulation in order to avoid these premature explosions. I have seen engines so governed in operation and the temperature of the cooling water when leaving the water jacket did not exceed 30-35° C (87-95° F); with engines having a lower compression, it can be made to leave at 50°-60° C (120°-140° F) without difficulty.

The "conical-cam" system requires further the use of a very heavy governor, sufficient to overcome the resistance opposing the motion of the cam, and due to the inertia of the pieces.

It must be considered that in practice, with engines using a mixture of variable quality, the machinist must manipulate the regulating butterfly valve of the air conduit when the load varies, so that a mixture which will explode readily in the cylinder is obtained.

Mixture of Constant Quality and Variable Quantity.—In this hypothesis the compression does not remain constant.

The quantity of the mixture drawn into the cylinder may be so much reduced that the compression will fall below the limit where ignition will take place. It is therefore necessary that engines should also work at high compression when supplied with this kind of regulation. The regulation of the quantity of explosive mixture is secured

in different ways. The most simple method is to place in the mixing pipe a butterfly regulating valve, which, operated by the governor, will throttle down more or less the passage of the mixture.

An excellent practical solution of the problem is to vary the opening of the mixing valve itself. In order to do this the valve is moved by a system of levers. The point of application of one of these levers may be changed through the action of the governor, so that the stroke of the valve can be made to vary between determined limits. Under these conditions, a mixture which will always be homogeneous,

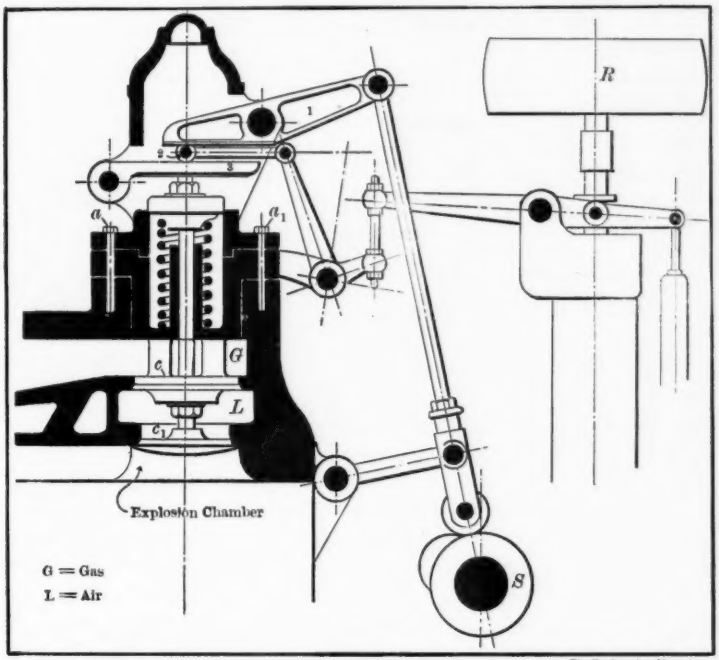

FIG. 7. SYSTEM FOR VARIABLE OPENING OF THE MIXING VALVE.

and of such proportions that ignition will occur even at low pressures, can be introduced into the cylinders.

I have ascertained, during recent tests of an engine supplied with these governing devices, that ignition was still obtained when compression went down to 3 kilogrammes per square centimetre (42.7 pounds per square inch). Besides this, a very economical consumption at half load as well as at full load has been demonstrated.

This system also has the advantage that ordinary governors which are not excessively heavy can be used, since the work to be done by these governors in order to change the point of application of the lever is relatively small.

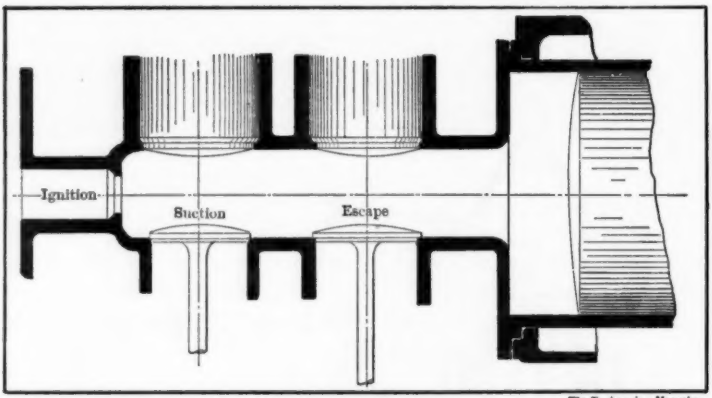

FIG. 8. FORM OF HEAD END IN WHICH THE INLET AND OUTLET VALVES ARE IN JUXTAPOSITION IN THE AXIS OF THE ENGINE.

If the employment of a certain method of governing has a direct and important influence on the consumption of the engine, the form adopted for the construction of the head or valve end plays an equally important part.

English designers have tried to approach a spherical form as much as possible. With this form of head end a compression of 6 to 8 kilogrammes per square centimetre (90-110 pounds per square inch) can not be exceeded. Nevertheless, the gas-consumption of engines (that is, those of good construction) when running under full load is generally economical enough. It varies between 425 and 480 litres (15-17 cubic feet) per horse-power hour, for engines of 20-25 horse power, using a gas having a calorific power of 5,300 calories (600 British thermal units per cubic foot).

All German and Swiss designers, on the contrary, have adopted in the design and construction of the head end a form in which the mixture and outlet valves are placed in a pipe forming a kind of antechamber which is completely water-jacketed, and therefore assures a good and regular cooling of the valve seats.

With this arrangement, while the explosion chamber can quite well be reduced to a minimum, the great advantage from the point of

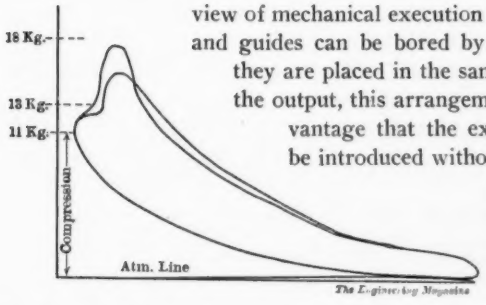

FIG. 9. DIAGRAM OF GAS ENGINE ON THE SYSTEM SHOWN ON PAGE 362.

view of mechanical execution is that the valve seats and guides can be bored by the same tool, since they are placed in the same axis. Considering the output, this arrangement again has the advantage that the exploding mixture can be introduced without being heated when passing through the admission valve, since the latter is benefited by the cooling of the head end which is completely water-jacketed. Before arriving at this form of head end, other kinds had been used in which the inlet and outlet valves were placed next to each other in the axis of the engine itself. This arrangement gave great length to the head end and some sort of ignition was produced every two cycles, as the accompanying diagram shows. This model seems to have been entirely abandoned.

In double-acting engines the valve chamber is replaced by a cylinder head analogous to that of the steam engine. The exit valve is underneath the cylinder and the inlet valve above it and the piston travels over their openings during its stroke.

The diagrams obtained by me from double-acting engines show that the mean pressure obtained with this arrangement is much higher than that obtained with the cylinder head previously described. The arrangement adopted for double action would then seem to be advantageous. This consideration appears to have lead a Belgian designer to construct the cylinder heads of single-acting engines identically as it is done for double-acting engines. Experience will show whether it is advantageous to enter definitely upon this path.

TABULATING-MACHINE COST-ACCOUNTINC FOR FACTORIES OF DIVERSIFIED PRODUCT.

By Morrell W. Gaines.

A GREAT deal has been written about cost-accounting method. Of able and illuminating expositions of the subject the articles that have appeared in THE ENGINEERING MAGAZINE are among the best and the most complete. Cost-accounting analysis, on the other hand, has, in proportion to its importance, been as yet touched upon but lightly. Description of forms is, it is true, not altogether unaccompanied by elucidation of principles. But on the whole the science has been slighted in favor of the art. The objective of this short, general paper is, accordingly, the logic of costs from the view-point of the cost-analyst. Concrete illustrations, pertaining to the province of the cost-executive, will be introduced as auxiliary to the main theme, and only so far as necessary.

In theory all cost-accounting method is based upon, and derives its validity from, cost-analysis. The one is the plan of which the other is the execution. A cost-system thus constructed aims at two results. The first is negative—the curtailment of waste and expense. The second is positive—the making of increased profits through knowledge of profit-bringing qualities and conditions. Of the two the latter is vital, and the former merely incidental, though often the more emphasized. Factories are run to make money and not to practise economies.

In practise, cost-accounting method does not generally conform to correct principles of cost-analysis as closely or as completely as it should. This is in part due to lack of insight in the design, in part to lack of flexibility in the accepted medium of expression.

Cost-keeping by hand, with its hard-and-fast entries in ink, is at best but stiffly adaptable to the many-sided interrogations whose answer it is its function to provide. Limitation by rigidity of form, which makes it represent as absolute conclusions that are only conditional, is its great defect.

Cost-accounting by tabulating machine, (touched upon as to method by Mr. A. W. Buel, in the August number of THE ENGINEER-

ING MAGAZINE), offers, on the other hand, the utmost flexibility, or, rather, fluidity, in mode of expression. Without the necessity of transcribing, its records permit the application of re-classification after re-classification to the same set of facts. They are, accordingly, for all analytical purposes infinitely to be preferred to the fixed-form, ink-entry records. The stride in advance is indicated, but not measured, by the analytical advantage of modern bookkeeping over the old single-entry process. New methods there have achieved one, or, at most, two, added classifications. Here at one step a facile multiple (not merely double or treble) classification is substituted for what was previously as a rule a single classification. The revolution in method admits now for the first time absolutely free and close application of searching analysis to cost-accounting.

The fundamental principles to be applied are few and simple. For the first function of cost-accounting—the curtailment of waste and expense—the old rule of classification according to units of product, in connection with scrutiny of expense totals, quite covers the ground. What is needed is simply the measurement and weighing of the physical results of expenditure.

For the second, and more vital, function of cost-accounting—the providing of a profit-criterion—measurement must be applied to receipts as well as to expenses, and that in more than one direction. Multiple classification, with several basic units, must be employed.

All knowledge of potential profits that experience may teach or reason create is, reduced to its lowest terms, no more than knowledge of the net difference in profit or loss which may be expected to follow choice between given lines of action. To determine this net difference with the greatest practicable accuracy is the main object of a cost system. For the profit-criterion, the fundamental principle is accordingly that of measuring differentials. This is a very different matter from the measurement of absolute quantities, to which cost systems too much confine themselves.

To cover the field of possible choice of action completely, producing units must be added to production units. There must be taken individual and group units of either class. The workman, the machine, the article, the salesman and the customer may be cited as examples of individual units; the department, the State or other division of locality, the combination of related articles into groups are instances of group units. All manner of units are useful in their place, but since problems requiring decision tend to narrow themselves within definite, circumscribed portions of an active business,

comparatively few of them will be required currently in the cost system. Further, since it is obvious that only that part of the receipts or expenses which is influenced by a given choice of action needs to be subjected to measurement in order to determine the resultant net profit or loss, a sharp, and most important, distinction is to be drawn between those receipts and expenses that are "direct" with respect to the course of action in question and those that are "indirect." All that will not vary with the choice of action are to be altogether discarded from consideration. This is not so much from motives of clearness and efficiency as of exactitude. The question of quantity of product is, in one shape or another, at the bottom of all questions of choice of action. If factors are included which do not vary with quantity the calculation becomes fallacious with respect to that very change of quantity upon which the whole profit-problem rests.

Direct and indirect charges are separated once for all in the ordinary type of cost system, regardless of the fact that charges which are direct, or within the sphere of influence, for one line of action may be indirect for another, and *vice versa.* Action involving increase of output beyond a certain point brings in at once new "indirect" charges. Action involving increase of output up to that point does not. Action affecting salesmen or foremen must rest entirely and directly upon "indirect" considerations. Change of material, of mechanical process, or even in the general complexion of the factory's output, may not only alter the direct labor expended on a given article but also may affect a whole series of expenses classed as "indirect." In any such case the "cost" of the individual article will not show rationally what has happened. Its coat of "direct" and "indirect," of unvarying pattern and size, can not be cut to fit the cloth of circumstance. An even greater source of confusion lies in the fact that the figures for total cost contain in indiscriminate burial factors that vary with change of quantity and factors that do not. The usual total-cost figures are accordingly not adapted for measuring profit differentials. When used as a basis for judgment, as they often are in the absence of anything better, conclusions are always somewhat wrong, and, sometimes, totally misleading.

Vexed waters lie deep over the question of proper apportionment of indirect charges. The differential plan circumnavigates the whole trouble by ignoring indirect charges altogether. On its schedules all items are direct although no charges are omitted. As is often the case, a little more complexity in the analysis produces a great deal more simplicity in the practice. For purposes of price-making, to be

sure, some will undoubtedly prefer to cling, at least in part, to the established customs of reckoning. In that case the arbitrary increments can be used as before, without hindrance. But, as will be shown later, this is not only a waste of time; it is also by no means the better method. The tabulating machine provides more accurate, as well as simpler, means of approaching its goal than ink-entry cost-accounting is capable of.

In estimating the net profit or loss to be expected from choice of action, the first step is to pick out the units of expense (and receipts) suitable for measuring the effects of the particular class of action. Direct expense per unit subtracted from direct receipts per unit gives then direct net revenue per unit, or net contribution per unit toward all those expenses which are outside of the sphere of influence of the action, and which are with respect to it just as much "fixed charges" as are those especial charges which are "fixed," or invariable, with respect to all choices of action alike. This net revenue per unit being multiplied by quantity gives in comparative form the total difference in net profit or loss capable of being caused by choice. Subject to the necessary allowance in all cost calculations for margin of error, the process evidently affords the best possible rational basis for arriving at conditions of maximum profit.

Before proceeding to the application of these abstract general principles it will be necessary to give some description of the tabulating machine and its *modus operandi*. Data are recorded by means of perforated cards whose arrangement may be so contrived as to fit any required schedule of units. Much care should be exercised in drawing up the details of the cards. As a rule, one schedule for expense and another for receipts may be made to include all necessary categories. There should be no hesitation, however, about using an additional form for any part of the records not easily assimilable to the rest. The main point, in fact the only essential, is to cause to be recorded by the machine *all* the direct expenditures and receipts originating under each of the chosen categories. Totals of outgo and income divided by totals of quantity give then cost and price figures about which there is no estimate, no omission, and no mistake. As regards accuracy, and immediate availability, of results—particularly where manufacturing processes are complex or output diversified—there is a decided advantage over the superseded method of building up costs out of approximated details. Shifting conditions can be followed. The actual costs of the moment can be worked out at short notice for any article desired. Facility replaces labor.

For the manufacturing side of the business, the cards should record date, list or catalogue number, order number, description of work done, hours worked, expense incurred, department, man and machine working, account to be charged, quantity made, and total expense. For the selling side, there should be recorded date, order number, customer, locality, salesman, freight and other especial expenses of sale, kind of article, quantity, and money value. These details should be gathered directly from the orders and other regular documents without intermediate rewriting. By means of a numerical code (which the operator memorizes) explanatory, or preparatory, dressing up of the figures is reduced to a comparatively negligible minimum. Ruled forms on the back of factory orders, or accompanying tickets, can be used to good effect both in lightening clerical work in the shop and in making an easy presentation of the facts to the machine. The fact that the information about an order may come to hand piece-meal, from many sources and at different times, does not in the least affect the ease of recording.

For the exclusion of uncompleted work from the final cost computations serial order-numbers should be employed in the works. Where partly finished material is used for more than one kind of finished article there must be a separate order number up to the point of diversion; the cost up to that point, having been arrived at, can be carried into the cost of the finished articles through the channels provided for "material used." Where the time of a man, or of a machine, belongs to two or more orders simultaneously, or is otherwise difficult of apportionment, there must, of course, still be partial reliance upon estimate, or upon experience.

Some lines of action are so seldom involved, and so readily approached through the medium of blanket totals, that their figures and their peculiar categories do not need to be entered upon the cards. Such are, generally speaking, those relating to expenses of investment, as for example outlay for plant, patterns and machines, expenses of corporate existence, as those for taxes, time depreciation and fixed interest, and expenses of organic maintenance, such as shop "overhead" charges, much of the "general" expense, and, largely, cost of power. All these can be better taken into consideration in bulk than in detailed apportionment in those infrequent, but not unimportant, relations where they are appropriate. Outbound freight can not usually be further subdivided than by locality and customer. Sales expenses, "indirect" from the standpoint of manufacturing problems but best considered "direct" from the selling point of view (because in

a rightly managed business they ought to vary with quantity of sales) resist dissection to a still further degree.

Although the information recorded is much more extensive than under the older cost systems, the operation of the machine is both rapid and cheap. Three thousand to four thousand cards punched per day per operator is a fair average. The principle is, as nearly as may be, one punch to a fact. Preparation of data before punching is quick work. Sorting of the cards, running them through the machine, and taking off results, is automatic. As incidental to the general process, records of daily sales, pay-roll and time figures, along with much, or all, of the intricate classification work previously carried on the books, may be developed, or checked, without additional labor and with a great saving of accounting department time. It takes two or three months only to train an apt green operator sufficiently well to ensure accuracy. The net cost is not at all heavy.

NET REVENUE FROM MANUFACTURE

MONTH OF_____ 190

		SALES		DIRECT COST					NET REVENUE			
CLASS OF GOODS	NUMBER	VALUE	AVERAGE PRICE	MATERIAL	LABOR	MISCELLANEOUS	TOTAL PER UNIT	TOTAL FOR GOODS SOLD	PER UNIT	TOTAL	PERCENT OF SALES	PERCENT OF LABOR COST
A												
B												
C												
D												
E												
F												
ETC.												
TOTALS												

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FORM FOR ANALYSIS OF REVENUE DERIVED FROM SALES OF VARIOUS CLASSES OF PRODUCT.

As to the extent to which the records shall be used, and indeed as to their completeness and form, wide latitude is allowed the individual management. Just as the preceding paragraphs on principle and means have conveyed the barest outline, so those that follow on practical application are a shadowy and incomplete sketch.

On the manufacturing side of the business one of the most common forms of choice of action is that which arises when the relative profitability of different lines of goods is under consideration. The problem may be reduced to its working elements by the use of a form like the one above, filled in periodically for all classes of product, and occasionally for one or more about which there is immediate question.

Net Revenue is the difference between actual Price realized and Direct Cost.

In a majority of instances the manufacturer will wish to consider the relative profitability of the different lines and classes of goods with reference to choice of action that will not involve changes in factory organization or in fixed investment. For all these cases the Net Revenue figures as arrived at on the above form will give him the profit criterion he seeks. Where choice of action reaches further, and disturbs the existing amount of overhead charges, or of other expenses herein discarded as being fixed with reference to the possible actions involved, the changes so induced in other classes of expense must be entered as "direct" under the necessary additional columns. The general plan is the same. All expenses not subject to alteration within the limits set by the inquiry desired to be made, are, as shown in the form, simply omitted.

As to the cost-analysis, or, better, profit-analysis, to which this statement conforms, it will be noticed that the plus and minus differences between successive net-revenue figures are almost, or quite, the same as the differences between the two corresponding net-profit figures would be if the usual total costs had been used, but that the relative proportions are altogether different. Some lines of goods too, that would show a negative net profit, keep, nevertheless, a substantial positive net revenue. The net-revenue figures show correctly, and in their true mutual relations, the contributions brought in by sales of the individual articles towards the general up-keep of the establishment. Therein lies their strength. The weakness of the net-profit figures lies in the fact that the tax for that general up-keep is subtracted from the contribution before comparison is made, so that what is finally compared is the resultant of two factors that obey separate laws of variation. Such a resultant is naturally not conformable to logical, law-following analysis, while either of the factors taken alone, and especially the more variable net-revenue factor, is conformable.

Net revenue per unit shows the additional income to be expected from an additional sale. It expresses the differential of gain or loss for the choice of action with respect to which the selected unit is the measure of force. The amount to be made or lost by increasing, or cutting off, sales of any class is apparent on the very face of the sheet. The net results to be anticipated from "pushing" one line of goods at the expense of another, of substituting one line for another, of raising or lowering prices (where probable effect on quantity of sales is known) can be readily computed. Diagrams for graphic

analysis will be simple straight-line figures, and they may be used to great advantage.

As to practical results, the manufacturer who is not getting the income that he ought out of his business can see, spread out in detail, where and why the deficiency arises. Sometimes loss of earnings comes from laying too much emphasis upon specialties, or small lines of high-profit goods, to the neglect of the tonnage-making low-grade articles. The fallacious relations presented by net-profit figures have a strong tendency to bring about this condition. Sometimes, on the other hand, the wider market for low-margin articles tempts manufacturers too far away from vigorous pursuit of profits that would come from a greater individuality of product and more energy in placing it. All such distortions of judgment, or lapses in economic efficiency, can be corrected in the light of the true proportions of the net-revenue figures. They give for each line of goods the full story of the relation of volume of business to final income.

Conformity to the relation between volume and profits is the essence of profit-efficiency in manufacture. Yet as a practical matter the considerations that may be deduced from a similar analysis of the selling side of the business are still more important. That side is where the money comes from.

For the salesmen, and other selling agencies, a form like the following should be filled in at least once a year.

COMPARATIVE NET REVENUE OF SALESMEN

YEAR 190___ SALESMAN_____

	SALES			DIRECT COST		NET REVENUE	EXPENSES OF SELLING				NET REVENUE FROM SALES		
CLASS OF GOODS	NUMBER	VALUE	PRICE	PER UNIT	TOTAL	TOTAL	FREIGHT	SALARY ECT.	TRAVEL	MISCEL-LANEOUS	TOTAL	PERCENT OF SALES	PERCENT OF DIRECT COST
A													
B													
C													
D													
E													
ETC.													
TOTALS													

The Engineering Magazine

FORM FOR ANALYSIS OF SALESMEN'S RETURNS.

This form is arranged with reference to the salesman as the unit. Units of production are used as far as the first Net Revenue (from manufacture) Total, simply for the purpose of obtaining that total. The ensuing figures are not divided by classes of goods. The sheet

measures the results of the salesman's work. It has two immediate effects. One is that, like Taylor's unit-time measurements for the laborer, it puts men on their mettle. The other is that it enables proper choice to be made of the class of salesman, and of the individual in the class, best adapted to bring in profits. Manufacturers have more at stake in the quality of their salesmen than jobbers—in proportion, that is, to the amount of business done. That is because the net revenue of the latter is so much smaller, 'direct cost' for the jobber being the price the manufacturer gets from him. Slack, desultory selling mechanism on the part of manufacturers would be remedied if the real import of the salesman's doings were measured through net-revenue figures. Cheap men can not be expected to be efficient. The pay should be proportioned to the importance of the job, and to the effectiveness of the incumbent.

Localities where selling expenses are not earned can be sorted from those where they are by means of a locality statement, drawn up substantially in the same manner as the salesman's statement. Deadwood can then be cut out. By taking states, or districts, as the unit in this locality statement, an interesting and valuable analysis of the sales territory can be made.

To return to the salesman proper; comparison of the prices he gets with those realized by other salesmen, and examination of the proportions in which he sells the different lines, will do much to show what his weaknesses and failings are. Gumption from headquarters can be infused at the right spot.

The salesman's sheet, in connection with the locality sheet, is of further interest as affording a basis upon which to decide whether to enter new fields of sale. The advantage to be gained by widening the market is not by any means indicated by the net profits on the new amount of sales. This is especially so because just at the moment when general consumption slackens fixed charges per unit rise and net profit decreases or vanishes. It is, however, precisely then if ever that an enlarged market is needed.

Price-fixing is ordinarily determined more by the market than by what the manufacturer *wants* to get. Where there is an option, price should be set to bring in the maximum total of net revenue, always, however, with an eye to the probable competition. Absolutely the only use of the complicated addition of arbitrary percentage loading to cover indirect charges is that the process, being similar to that of competitors, gives an approximate idea of the prices they will make in competition. As the arbitraries are unlike in different factories,

this psychological advantage does not invariably hold water. To cite a case that has recently appeared in print, Mr. James Newton Gunn's experience with machine shops has been that it is necessary to take small jobs to small shops because the shops with big equipment throw their big fixed charges into their estimates. Direct expenses being equal, there would, of course, be just as much money in a given price for a large shop as for the small one. The theory of arbitrary loading has simply gone astray. This is by no means an isolated case. The number is legion of businesses that have decayed because the proprietors persisted in using arbitrary loadings suitable to internal conditions of the factory rather than to external conditions of the market. Still it is perfectly feasible for the manufacturer, using the new system, to set his prices by any means that suits him. All that is essential is that he should check his price, when set, by making up the net revenue figures to see what his returns really are.

Forms, similar in plan to the above, can be drawn up to fit other needs. Records of men, of machines, of departments, of product groups, and of producing groups can be kept. These may be arranged for comparison with own past performances or with the performances of other homogeneous units. Every problem of choice of action, from those involving new investment to those concerned with concentration of production among existing factories, can be best and most clearly viewed when thus resolved into its direct elements.

In every walk of life there is a sufficiency of those who object to going without crutches. Bookkeeperish minds are particularly prone to the failing. The freedom of this type of analysis is not likely to be relished by the "finished-and-finite-clod, untroubled-by-a-spark" sort, especially since there have been most satisfying, exact and methodical, forms to lean on. Cost-accounting truly belongs, however, to the trained mind of larger grasp and firmer footing. It should be one of the paths by which the engineer pre-eminently, from the very nature of his training, aims to pass upward to a sphere of wider and more intimate contact with the external problems of the business. That way lies increase of influence, as well as increased usefulness.

The new system means facts for the "practical" man, insight for the analytical. For the trained engineer, as for the broad-minded executive, it offers knowledge that is power.

PROBLEMS OF THE EXPANSION OF THE AMERICAN COAL TRADE.

By Frederic Edward Saward.

In a preceding article, Mr. E. C. Eckel, of the United States Geological Survey, pointed out the enormous proportionate part played by the coal and iron industries in the total mineral production of the United States. The accompanying paper by Mr. Saward, editor of the *Coal Trade Journal*, deals in more detail with the factors affecting the present and future of American coal mining and export. It will be followed shortly by another contribution from Mr. Eckel, pointing out most instructively the important significance of recent progress and immediate prospects in the American iron and steel trade.—THE EDITORS.

THE whole history of coal is a wonder story. It is wonderful in many ways—from its use as a source of motive power, from its value as an earner of income to the owners, and as freight to the carriers. Coal gave Great Britain the mastery of the world's markets and its carrying trade, until Germany and the United States entered the field effectively in the last quarter of the past century, when the development of German and American coals warmed these two countries into a neck-to-neck race for commercial supremacy. Starting in 1875, the race of the great leaders in coal production stood as follows:—

	Million tons (of 2,000 pounds each) Mined.				
Countries.	1875.	1885.	1895.	1900.	1904.
Great Britain	150	178	212	252	260
United States	52	111	193	269	352
Germany	53	81	114	164	186

If the rate of increase which has characterized the industry in the United States for the last ten years, or the average rate of increase for the last fifty years, should be continued, what an enormous output the next ten years will show! It will be, ten years hence, a tonnage in excess of 700,000,000 per annum. This amount is so great that one may well question if the railroad facilities of the United States will permit of such a growth. The whole freight traffic of the country today is one billion four hundred million tons. This includes duplication of tonnage to the extent of hundreds of millions, through cars of freight passing over two or more roads. It may be questioned if the actual tonnnage of commodities handled by the rail-

roads exceed in weight 700,000,000 tons, as so many shipments are counted in the freight traffic of from four to six railroads. There are some arithmetical progressions which soon reach the bounds of absurdity. Possibly the percentage increase in coal output, which the records of the past indicate, is one of these. At any rate, the figures are phenomenal, indicating, by the year 1909, an annual tonnage of 501,000,000 tons. Who can deny the potentialities of the coal trade? Is it not a fact that the extent and importance of this business is altogether unrealized by the general public? Do not the figures indicate a wonderful future for owners of coal land and for all who are interested in the business in a large, substantial way?

The following table shows the amount of the coal production of the United States in 1904:—

State.	Production.	State.	Production.
Alabama	11,163,194	Montana	1,359,409
Arkansas	2,009,451	Nevada	150
Cal. and Alaska	75,388	New Mexico	1,452,183
Colorado	6,594,295	North Dakota	269,297
Georgia and N. C.	400,191	Ohio	24,415,054
Idaho	3,330	Oregon	111,540
Illinois	35,990,796	Pennsylvania	97,916,733
Indiana	10,929,908	Tennessee	4,782,302
Ind. Territory	3,011,972	Texas	1,072,194
Iowa	6,542,005	Utah	1,491,607
Kansas	6,322,875	Virginia	3,576,092
Kentucky	7,559,940	Washington	3,135,757
Maryland	4,819,171	West Virginia	32,332,385
Michigan	1,338,447	Wyoming	5,177,381
Missouri	4,187,197		

Total Bituminous	278,040,244
Pennsylvania Anthracite	73,156,709
Grand Total (tons of 2,000 pounds)	351,196,953

The total for this year will be 5 per cent. more than that of 1904, as the trade demand has been excellent for the past four months; this means a daily output of over a million net tons of coal a day.

A large amount of the soft coal produced in the United States is mined by machinery. A record of the progress therein is shown in the following statement. It is noticeable that the great district of western Pennsylvania, Ohio, Indiana, and Illinois—the bituminous district wherein the United Mine Workers' organization is strongest—is the greatest user of mining machines.

Year.	Machines Used.	Tons Produced.
1901	4,341	57,843,335
1902	5,418	69,611,582
1903	6,658	77,974,894
1904	7,671	78,692,407

That the use of mechanical cutters is rapidly passing out of the experimental stage in Great Britain is evidenced by the following table showing the increase in the number of machines and the tonnage produced during the last three years:—

Year.	Machines Used.	Tons Produced.
1902.....	483	4,161,201
1903.....	643	5,245,578
1904.....	755	6,744,044

Thus there has been an increase of over 56 per cent. in the number of machines used, and an increase of over 60 per cent. in the product. The greater number of machines are used in the Yorkshire and Lancashire districts, and a great future is predicted for them in the Midlands. The South Wales district, noted for its "smokeless" coal, reports an output of 43,730,415 tons in 1904, but there are only nine machines in the Cardiff district, and their product amounted to only 40,986 tons.

There has been a vast quickening in the coal trade in the United States during the past few months, and it is claimed that it is due to short car supply. Whether there is really a scarcity of cars, or whether short transportation facilities are only apparent because of the great demand from all branches of the industrial world, the fact remains that coal producers are not able to secure as many cars as they need, and yet not damage the business so far as price is concerned. Every fall brings with it this condition, and perhaps always will, but it is worse now than ever before. There is no prospect that it will not be worse next fall than now. Railroad companies are purchasing an enormous amount of equipment, but it must be remembered that all lines of business are increasing in volume and that the railroads are covering more territory each year. Another thing, a large proportion of this equipment goes to takes the place of that which is worn out and goes to the scrap pile. Every firm or company that is producing coal must, therefore, understand that while there will be more business and a greater demand for fuel each year, transportation facilities in the fall will always be taxed—that is, when financial and industrial conditions are normal.

As to labor matters and the possibilities: There is a joint agreement between the men and their employers in the bituminous districts of the United States, covering what is known as the Interstate, or competitive, territory, which comprises western Pennsylvania, Ohio, Indiana, and Illinois, and this agreement, which was made in April, 1904, expires by limitation April 1, 1906. An under-

standing by which the anthracite miners received a basic rate of wages was entered into in April, 1903, and that also expires at the same time, in April, 1906. So it will be seen that where the United Mine Workers are strong, the wage agreements of both anthracite and bituminous miners expire at the same time, and of course new arrangements, or agreements, must be entered into before that date. A convention of the anthracite miners is to be held December 14, of the current year, to formulate demands for another year or more, while the Interstate district miners will meet in January to formulate their demands to be submitted to a joint convention of operators and miners, in February. The union leaders claim a membership to their organization of about 300,000 out of a total of 550,000 employed in the United States, and while there are many foreigners, such as Poles and Hungarians, employed in and about the mines, as a rule they are all good unionists, and they do not work for a longer period per day than in other countries, for the eight-hour day prevails in many States. It is a fact that since the union has gained strength in the coal industry, wages have been increased very materially, and there have been claims and demands almost every year for higher wages and for fewer hours of work. In the anthracite region the miner does not work an average of five hours per day, but the outside laborer, and the man who follows the miner to load the coal which the latter has dug, formerly worked ten hours, but by the decision of the Anthracite Commission this was cut to nine hours. The effort is to be made for a universal eight-hour day, such as prevails in the bituminous districts where the union is powerful. This is one of the great features of the union demands—a universal eight-hour day.

In the anthracite regions there was a 10-per-cent. increase in wages five years ago; there was another increase of 10 per cent. in 1903, and Mr. Samuel Gompers, of the Federation of Labor, estimates that the extermination of "store orders" and the payment of wages in cash is equivalent to a 10-per-cent. increase in the purchasing power of the wages of the miners. Formerly everybody was paid in orders on supply stores managed and owned by the operators, where every miner had an account and bought what he wanted on credit. At the end of the month, or whenever pay day occurred, he presented his order and it was credited on the books against the purchases he or his family had made. This credit system was a great temptation to the miners and their households; they bought many things they did not need, and bought more than was necessary of what they did need,

because they did not realize how much they were spending. Now that they receive their wages in cash, they can trade wherever they can get the best bargains, and as a rule they are much more economical in the expenditure of their money. Mr. Gompers thinks that it is worth more than 10 per cent. for a miner to have the privilege of handling his own money and buying where he can use it to the best advantage. Then they get an advantage in the rise of coal prices, of 1 per cent. on each 5 cents per ton advance. The minimum price was fixed by the Anthracite Commission, and wages are based on that.

In the ownership of the anthracite coal territory there has been increasing concentration in the past few years; the high prices offered make it profitable to the old owners to dispose of their property to the large corporations. Since 1896 the anthracite production and transportation has been conducted harmoniously by the corporations which control the industry. For several years it has not been necessary to hold conferences as to trade affairs. Each company proceeds apparently on its own initiative, year in and year out, but for a long time each of the great companies has produced a certain proportion of coal to the total output, prices have been steadily maintained, and on occasions the companies have stood together, as during the strikes of 1900 and 1902, yet they have been separate and apart. There could be no greater harmony of action than there has been in the last three years, if there were to be another dissolution of the nine companies and the creation of one corporation in their stead. But this unwonted harmony during so long a period between competitive companies engaged in the struggle for business and traffic was due, in great measure, to the artificial arrangement put in operation by President Roosevelt's strike commission which has dominated the anthracite coal industry, bringing not only the competitive producing and transporting companies into harmony, but encouraging the lion of capital and lamb of labor to lie down together. It is recognized that when this compact ends next April the forces of capital and labor will at once be arrayed against each other, the demand for an eight-hour day and recognition of the Union being the vexed points at issue.

The progress of the shipment of anthracite in the past few years has been as follows:—

Year.	Tons.	Year.	Tons.
1902.....	31,200,890	1904.....	57,492,522
1903.....	59,362,830	1905.....	60,000,000

The year 1902 was that of the long strike, lasting the greater part of six months, from May to September. In ten months of 1905

the shipment was 50,593,504 gross tons, so that the estimate of 60,000,000 is none too large for the current year.

That there are years of prosperity ahead of the coal trade is unquestioned; the mere enlargement of the American railroad system will take care of 5 per cent. annual increase in the bituminous output. From all present indications the year 1906 will see extraordinary activity in railroad building in the western part of the United States and also in the Dominion of Canada. Almost all the prominent railroad systems in the western part of the country, including the important Canadian companies, are contemplating the building of additional lines, for the purpose either of opening up to settlement new agricultural lands to supply the *bona fide* demands of the increasing number of new settlers who are desirous of taking up homesteads, or of tapping new mineral sections. There is also in contemplation by the railroad managers the building of many miles of new lines to shorten present lines and to avoid the steeper grades, which will, when completed, be a great factor in the more economical management of the roads. With a view of more expeditiously handling the traffic on several of the roads, there will also be built several hundred miles of double tracking, which will undoubtedly be the source of much additional revenue and of important economies in transportation when completed.

One of the most important features in regard to the American coal trade is the fact that so much of the coal is used at home. Great Britain exports are reported at 48,250,000 gross tons, and in addition there is supplied a total of 17,000,000 gross tons more to steamships engaged in the foreign trade. Exports from the United States—mainly to Canada and Mexico—are reported as amounting to 8,500,000 gross tons in 1904, and bunker coal is perhaps a total of 10,000,000 gross tons, so that the relative position is this:—

	United States.	Great Britain.
Production of all kinds.....	352,000,000	260,000,000
Exports and bunker.....	20,720,000	73,080,000

(Reduced to tons of 2,000 pounds.)

There are many producers in the United States who are of the opinion that the country should do more in the way of an export trade—particularly is this the case with those soft-coal producing concerns in the Southern States, where development is on a rapid scale. The solution of the problem of securing an export market, needless to say, is indissolubly bound up with that of enlarging the American merchant marine.

A TUNNEL ON THE GRUYÈRES ELECTRIC RAILWAY.

THE ELECTRIC RAILWAY OF GRUYÈRES.

By Emile Guarini.

The accompanying short illustrated description is given as typical of much of the work now being done in the construction of electric railways in Switzerland. The abundant water powers of the country are especially favorable to the development of similar traction enterprises and allied undertakings.—THE EDITORS.

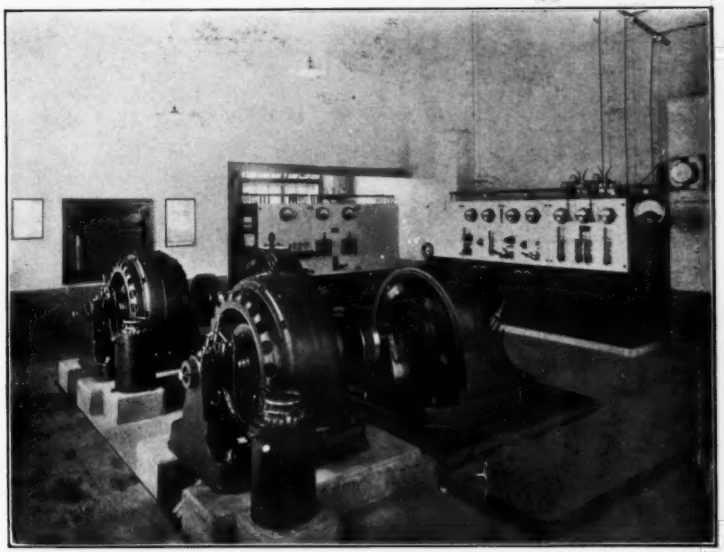
IT is only within recent years that a railroad has been in operation at Gruyères, Canton of Freiburg, Switzerland. This line, which is worked by electricity, connects Montbovon with Palézieux, passing through the towns of Albeuve, Bulle, Semsales and Châtel-St.-Denis. At these points transforming stations have been erected for the purpose of stepping down, to a tension suitable to the motors, the currents of high voltage which are supplied by the hydro-electric central station at Montbovon. This central station was erected through the efforts of the Alioth Company which has also equipped the system referred to.

The sub-station at Bulle is the most important; it is equipped with two sets of rotary transformers, each having an asynchronous motor of 250 horse power, direct-coupled to a dynamo. The asynchronous motors are fed directly at 8,000 volts by the three-phase currents from Montbovon. These currents are distributed among the sub-stations by means of sectional conduits so arranged that the total loss in the circuit does not exceed 12 per cent. under the most unfavorable circumstances.

The motors, of Alioth type (as are all the other apparatus used on the line) are each coupled flexibly to a generator furnishing continuous current at a tension of from 750 to 1,000 volts.

The load, owing to variations in the traffic, cannot be maintained at a uniform rate and is, therefore, regulated by means of booster batteries; that is, an accumulator battery of suitable capacity is employed in conjunction with the generator. This insures the apparatus working under conditions as near the full load as possible.

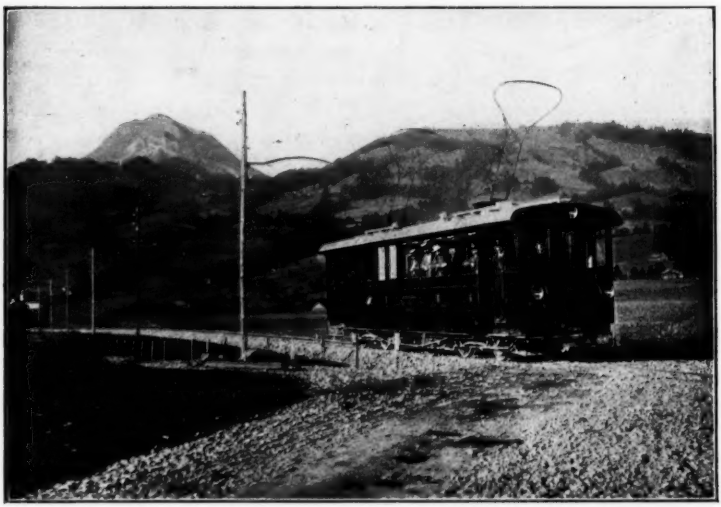
At Bulle the battery has a capacity of 370 ampere hours and is formed of 375 elements. This battery is charged during the slack hours of the traffic, that is to say when there is least traffic demand



INTERIOR OF TRANSFORMER STATION, ALBEUVE.

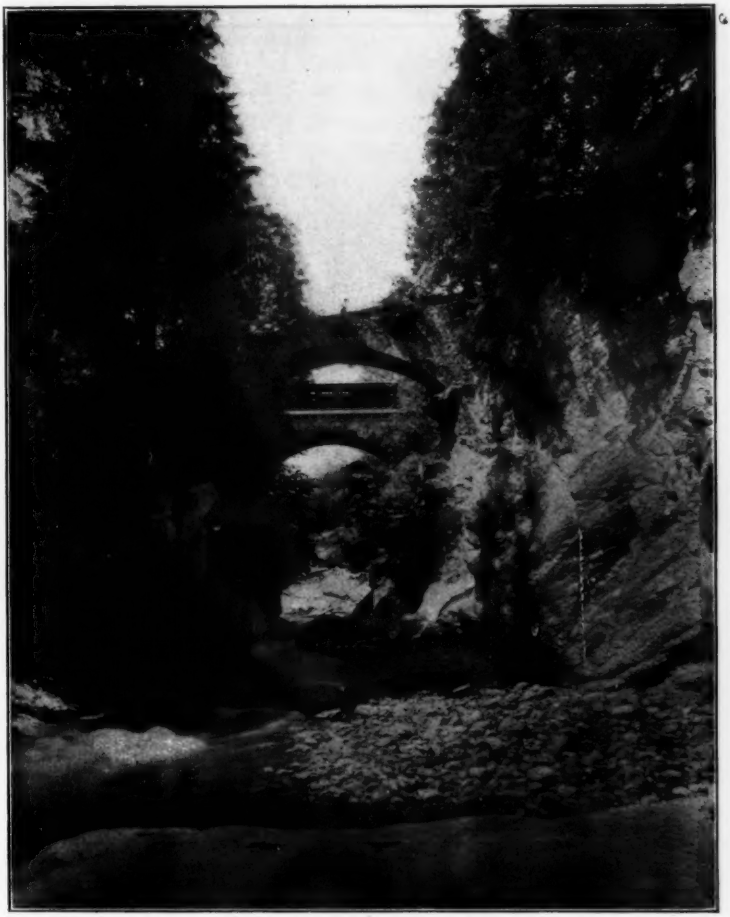
for current on the line. In proportion as the railway use of the current increases, the potential is lowered to the limits of the generator. A moment occurs when the battery no longer receives current, and, in fact, when, the load still increasing on the line, it restores to the latter the power which it had accumulated from the generator.

Similar conditions prevail at Albeuve, Châtel-St.-Denis, and Semsales; but there the apparatus is less powerful; each sub-station simply has two sets of 70 kilowatts, with a reserve set of the same power, which could be utilized in case of necessity. A similar reserve group, but of 170 kilowatts, is also provided at the sub-station at Bulle.



A MINOR ROAD CROSSING. SHOWING THE GENERAL CONSTRUCTION OF THE LINE.

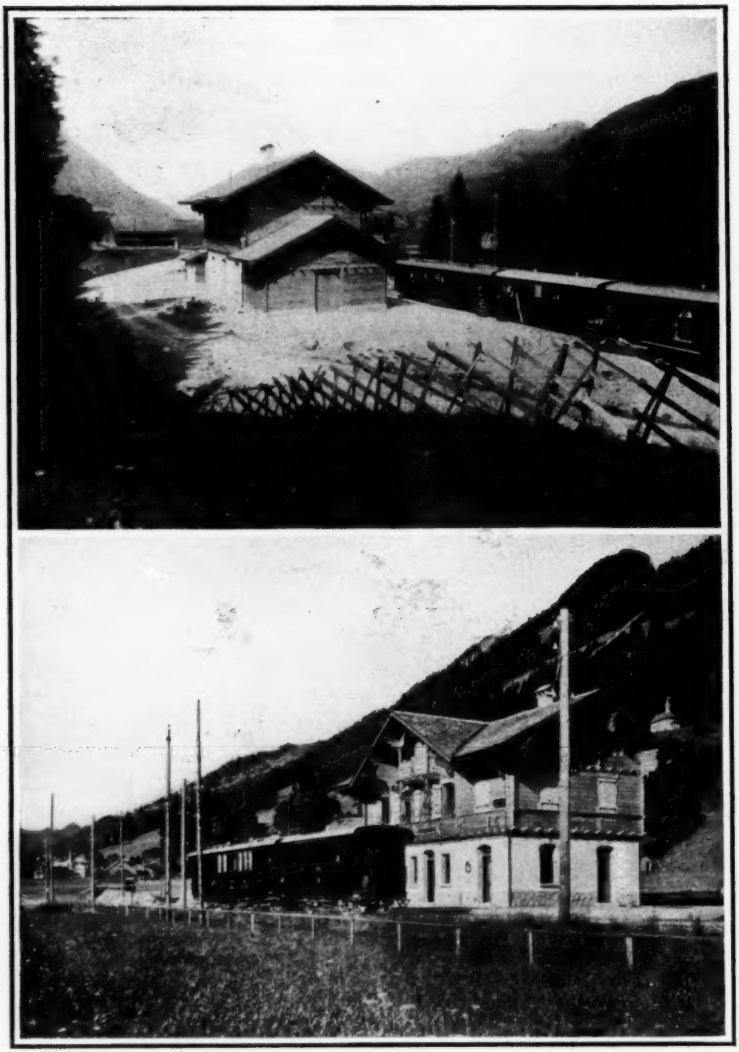
The groups of transformers consist each of an asynchronous motor, coupled by a flexible sleeve to a continuous generator. These machines make 500 revolutions a minute, the frequency in the case of the motor being 50 periods per second. Here the machines do not receive current under 8,000 volts, a preliminary transformation taking place in the towers, on entrance into the sub-stations, by means of a static reducing transformer, which brings down the electric pressure to 500 volts, the tension at which the current is employed in the motors. Near these, in each of the sub-stations, are placed the starting apparatus.



RAILWAY AND ROADWAY BRIDGES.

The batteries in the last three transforming stations have a capacity less than that mentioned for the Bulle station. The capacity, which can be consumed in an hour, is only 115 ampere hours, the number of the elements being reduced to 170.

The switch-boards are formed of panels of white marble, set in wrought-iron frames, with partitions of perforated sheet iron. This



EXAMPLES OF BUILDING CONSTRUCTION AT MINOR STATIONS.

The upper picture shows the station at Lessoc; the lower, that at Grandvillard.

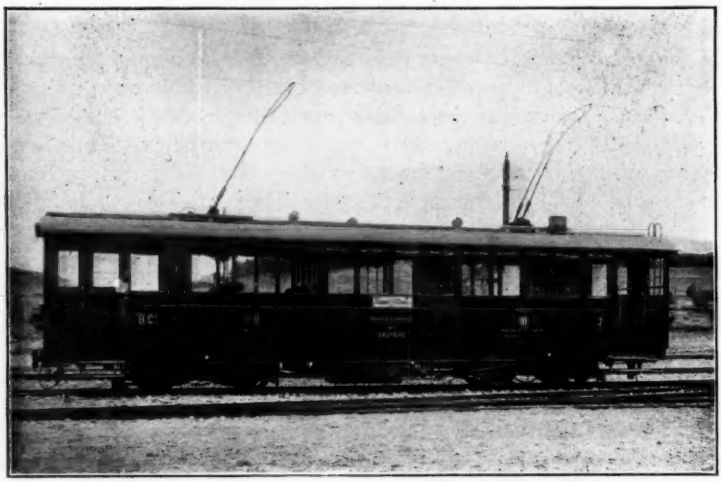
ensures proper ventilation and protects the apparatus from all danger of contact.

There are three tri-phase panels and four continuous-current panels, the two groups being separated but well within sight of the electrician. Each of the three-phase panels corresponds to one of the groups and carries the necessary measuring, controlling, and safety apparatus. One of the continuous panels is reserved for measuring the tension of the feeding and charging currents. The other three are used for the generators.

A PRINCIPAL STATION—CHÂTEL ST. DENIS.

The conductors are led into the building through specially constructed towers. The continuous current of 750 to 1,000 volts, produced by the generators (assisted, when necessary, by the batteries) is conveyed to the overhead conductor. This is formed of hard-drawn copper wire, of 9 millimetres diameter (or a section of 63.6 square millimetres) and supported, by means of insulators, on pine-wood posts treated with an injection of chloride of zinc; this increases the resistance to the earth acids and protects the posts from the weather. The suspension is generally effected by special brackets, but double masts with wire stretchers and guys are also used, this method being adopted on curves.

The height of the wire above the rails also varies according to local-



A MOTOR CAR ON THE GRUYÈRES RAILWAY.

ity; in all cases, however, the suspension is elastic, so as to avoid the necessity of reversing the collector used in taking up the current. This collector consists of a large metal ring kept in contact with the line by means of springs, the upper part, which consists of an aluminum band, rubbing against the electric conductor. The suspension points of the wire are so arranged as to distribute uniformly the wear on the bow trolley. It might also be added here that, in order to facilitate repairs and inspections in case of accidents, the line is divided into sections of 1,600 metres long; the posts are placed 40 or 20 metres apart, 20 metres being the distance at curves. Every fourth or fifth post is provided with a lightning arrester. The feeder cables and the telephone lines are suspended from the same supports which carry the overhead wire; the height of the posts is 8, 9 or 10 metres, and they are set 1.25 to 1.75 metres in the ground.

From the line, the current passes through the flexible bow trolley to the controller. The motors are of 35 or of 60 horse power. There are six motor cars regularly used and three held in reserve, each equipped with four motors of 35 horse power; and two motor cars, with a supplementary one in reserve, of higher power. The four small motors are always connected in two groups of two motors in series; the large motors, in two groups of two motors in parallel.

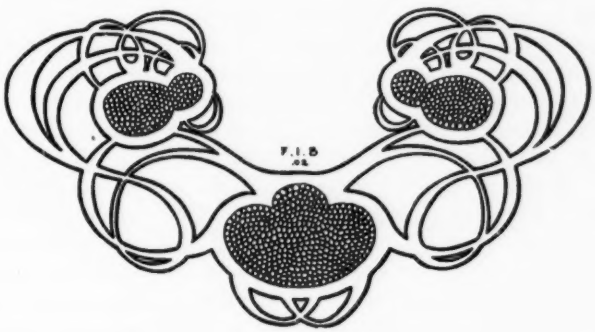
The groups are, in turn, placed in series or in parallel by the aid of the controller, as required.

The rotary speed of the motors is 550 revolutions a minute. This is reduced to the requisite wheel speed by gearing. On steep inclines the speed is maintained at about 20 kilometres an hour for ordinary passenger trains (47 tons) and 17 kilometres for goods trains (60 tons) and large passenger cars (130 tons, with four motors of 80 horse power).

The electric current is also employed for lighting purposes; five lamps of 150 volts are placed in series between the conductors (line and earth); it is used also for heating radiators, each having two windings in series permitting three grades of temperature being maintained; while a small motor works a pump which controls the pneumatic brake with which the cars are equipped.

The cars themselves are commodious and of elegant construction, being built of oak and pine, with fronts of sheet iron.

The roadway consists of two rails placed at a distance of 1 metre apart and resting upon a well ballasted surface, 2 metres wide and 35 centimetres deep. They are attached transversely every 200 metres by means of copper wire soldered at both ends. The rails are electrically bonded. To effect this bonding, the ends of the abutting rails are carefully scraped and cleaned in place, after which there is applied, with the interposition of a plastic amalgam, a copper plate measuring at least 100 square millimetres in section, which is firmly fastened in place by means of an angular fish-plate.



HIGH-SPEED STEEL IN THE FACTORY.

By O. M. Becker.

IV. FUNDAMENTAL CONSIDERATIONS IN THE DESIGN OF TOOLS AND MACHINES.

Mr. Becker's articles, prepared in part in collaboration with Mr. Walter Brown, are based upon an exhaustive "try-out" of the new alloy steels in one of the largest American shops. The series began in our issue for September last, the first section being devoted to showing that the manager will generally find it to his advantage to replace carbon-steel by alloy-steel tools only gradually, under expert advice, and to adapt his existing equipment, so far as possible, to the new conditions and work it to the limit until it is worn out. The second part dealt with the internal adjustment of shop conditions—both as to men and jobs—to the use of the modern tools. The third (last month) took up in working detail the manufacture and treatment of alloy-steel tools and the apparatus needed for that purpose. The paper now presented deals with the operation of the tools and the machines carrying them.—THE EDITORS.

OBVIOUSLY, the prime motive in machine and tool design is efficiency. One productive apparatus is preferred to another because it turns out a greater quantity of the required product at the same or a less cost. Highest efficiency then involves the maximum production (satisfactory in quality) at minimum cost. Now the chief element in cost is usually that of labor—that is to say, time. Wherefore it is commonly assumed that a tool which works most rapidly is *ipso facto* most efficient. There are however other considerations not infrequently of equal importance with time. Certain of these, as the proper making of the tool, have been already discussed; and others, as the influence of the machine in which it is used, will be touched upon hereafter. It remains to consider here the influence of design on the efficiency of tools.

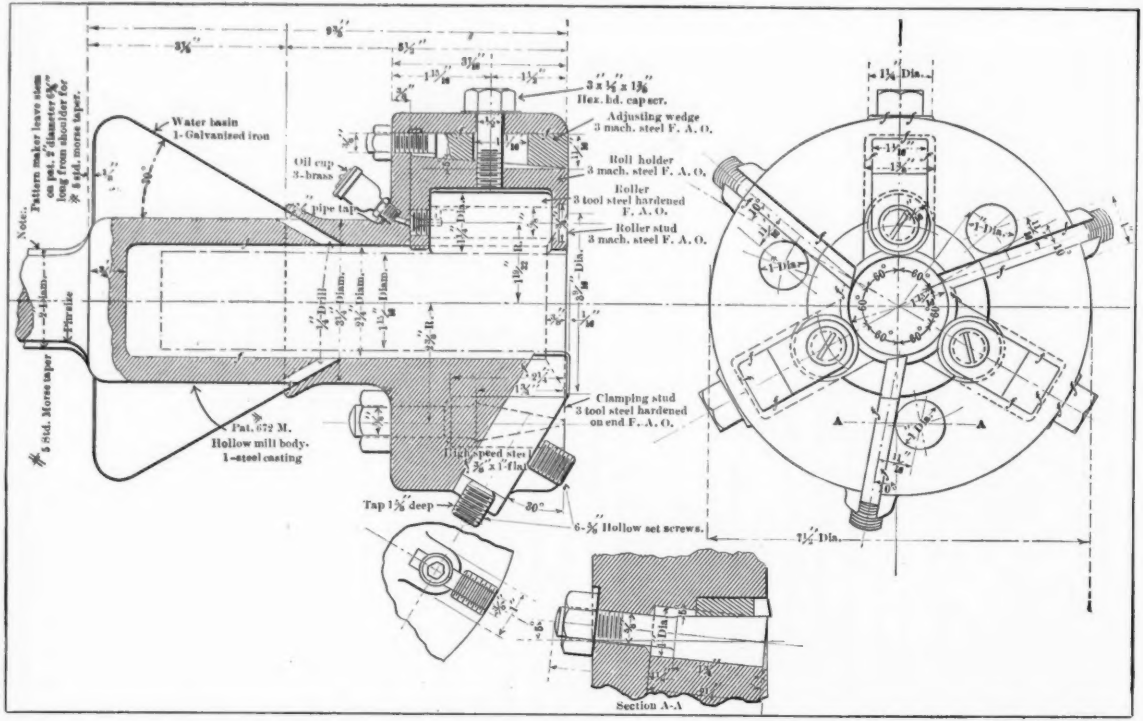
It has been already pointed out that the new conditions involved in the use of high-speed tools necessitate greater cross section in most of them than has heretofore been customary. The exception is found in such tools as large reamers and cylindrical cutters, which have generally been heavier and stronger than necessary because the expense of machining away the excess of metal brought no particular compensation. For lathe tools, and others of similar form and method of holding, a section from a fourth to a half greater than the minimum

permitted to a carbon tool working at the old speeds, will usually suffice. Peculiarities of form, or extreme speeds and exacting requirements as to quality of work, may occasionally necessitate even more metal.

In the first days of alloy steels, when unannealed stock was recommended and used almost exclusively, the tool holder, permitting the use of comparatively light stock and necessitating little waste, bade fair to solve the problem of keeping the first cost of tools of this class at the minimum. In fact, when so used, the first cost of such tools, considered on the basis of work finished, is almost without exception less than that of similar tools made of other materials. The criticisms that such holders and tools lacked the requisite stiffness was soon silenced by the appearance of heavier holders. They are now made so heavy and with such excellent arrangement for gripping the cutter that little remains to be desired in this respect. There is however one objection to their use which at present appears impossible to overcome, namely the inability of such a combined tool and holder to conduct away the heat generated in cutting, as rapidly as is necessary to permit working the tool at its maximum speed. Increasing the amount of metal in the holder does not wholly obviate the difficulty. The reason seems to be that the alloy steels are much better conductors of heat than carbon steels. When the one is combined with the other, the small piece of alloy steel is unable to get rid of the heat developed in cutting as rapidly as is necessary when working at a high speed, and is likely to be burned.

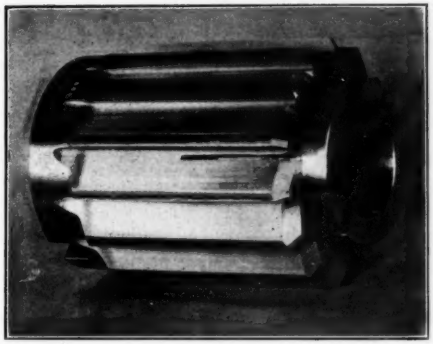
The same objection holds in the case of tools with a carbon-steel body having brazed cutters of high-speed steel. For some classes of work, as where the highest cutting speed is for any reason undesirable or unattainable, such tools serve as well as any others. But in general the highest efficiency will be attained through the use of a solid tool of alloy steel. Of course the first cost, in the case of heavy tools, is apparently large; but it has been already pointed out that the only fair comparison in the cost of tools must take into consideration the relative quantity and quality of work produced. A high first cost therefore does not necessarily signify anything, and good practice indicates the use of the solid tool.

The same considerations do not hold good to a like degree in the case of reamers and milling cutters having comparatively heavy cores. Here the danger of burning the cutting edges is less imminent. There is nevertheless another difficulty that often causes trouble, namely that of securing sufficient clearance for the increased amount of bor-



The Engineering Magazine

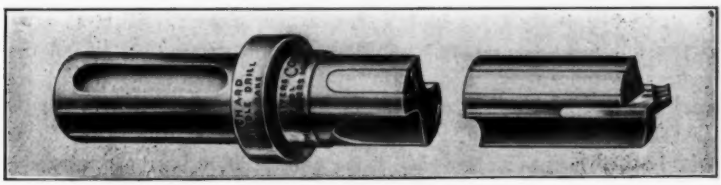
INGENIOUS AND HIGHLY SUCCESSFUL HOLLOW MILL, INVENTED BY MR. WALTER BROWN.



MATTHEWS FOUR-INCH EXPANDING-SHELL CORE DRILL.

Made by Three Rivers Tool Co., Three Rivers, Mich. Patent applied for. Alternate flutes slotted at cutting end. Expansion is effected by a locking taper plug.

ings or cuttings and at the same time providing sufficient backing properly to support the inserted cutter. The determination of a happy mean may involve the use of fewer cutters than the customary number. The position in which the tool works and the material operated upon, that is to say, the nature of the particular job, will have much to do with the ultimate form of the tool. Obviously, a reamer working vertically on a job where the borings are removed by gravity presents fewer difficulties than one working horizontally as is sometimes necessary; and the chief consideration here will be to secure the requisite strength. The backing of the cutter is not the only thing that needs to be taken into account. The rigidity of the latter, and consequently its ability to stand up under heavy duty, depends equally upon the firmness of its seating and its attachment to the core. Unless the cutters are so solidly attached as to be practically a part of the core, the tool cannot be depended upon for continued service. The difficulty of making such an attachment by mechanical means is evident. Many tools of this class have been designed, and a considerable number put on the market. Some of these, particularly those intended to be used as floating reamers for sizing, rather than for boring, do very well in all but the heaviest work. For such duty it



CHARD DEEP-HOLE SPINDLE DRILL.

The Interchangeable double-lip cutting point is held in place by a taper pin. Made by Three Rivers Tool Co.

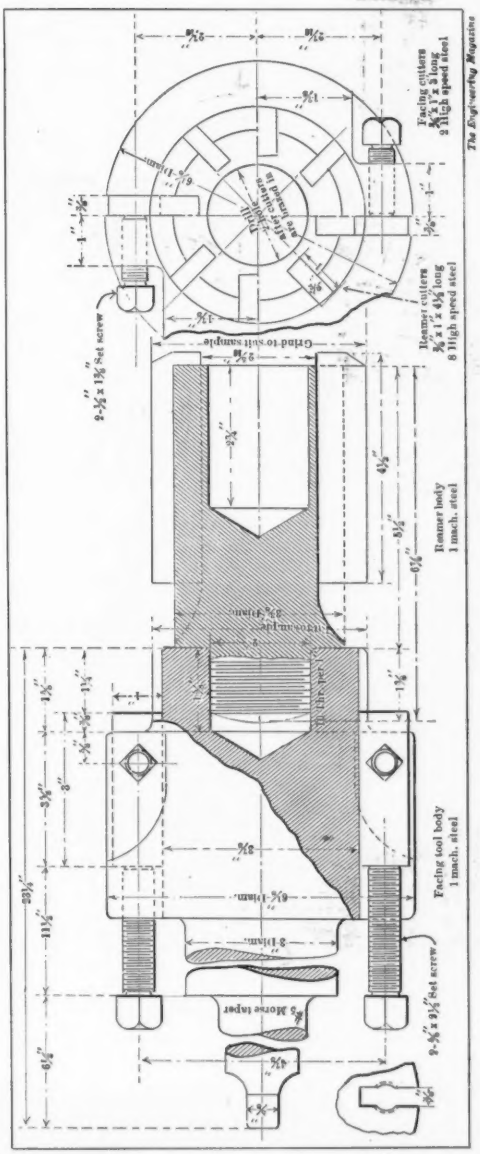
seems to be pretty well established that the cutters should be brazed or welded to the core.* Such a treatment gives the effect of a solid tool possessing the disadvantage of low heat conductivity but otherwise equally as good as one made entirely of alloy steel.

In the case of most milling cutters there is more room for attaching the cutters by mechanical means, so that there is apparently less advantage in brazing the cutters than there is in the case of reamers. On the other hand, there is a distinct advantage in mechanically attached cutting blades in that the same core may be used an indefinite number of times, it being necessary only to replace worn-out cutters with new ones. This obviously applies more particularly to the larger sizes of tools. Where it is necessary or desirable to use them of small diameters, the increased number of cutting edges possible to a solid tool gives that form a distinct advantage over the other in the amount of metal removed per revolution. The danger of overheating is small because only a few of the teeth are cutting at the same time, the remaining ones meanwhile being exposed to the air and cooling.

The difficulty of hardening solid tools of this class is also to be taken into consideration. It has been shown that such cutters, more especially when of large diameters, are very susceptible to flaws and cracks during the hardening process—cracks which often become manifest only when the tool has been put at work—sometimes long after. All things considered, the best practice seems to be to use inserted cutter tools in all sizes large enough to admit of its being done. Small disc and irregularly shaped cutters are obviously better made solid.

As to the mode of attaching mechanically held cutters to a core or body, it is safe to say that screws are in general to be avoided. The reason is pretty well understood among tool designers and users—namely the tendency of threaded parts to work loose and to require frequent replacement by new and over-sized ones. The materially increased cost of manufacture is also a consideration. Properly doweled insertions, fitted under pressure sufficient to insure solidity, are about as good as brazed cutter tools, whether they be of the reamer or miller type. In the latter case, and in reamers whose blades can be ground so as to leave the core intact, the cost is lessened by the repeated use of the same body with new sets of cutters. It is often possible in this way, even if the core be used but once, to make them at less cost than that of similar carbon-steel tools. The cost of

* The writer would be glad to learn of the experiences of others in welding high-speed cutters to carbon-steel bases and cores, particularly as regards the use of Thermite.

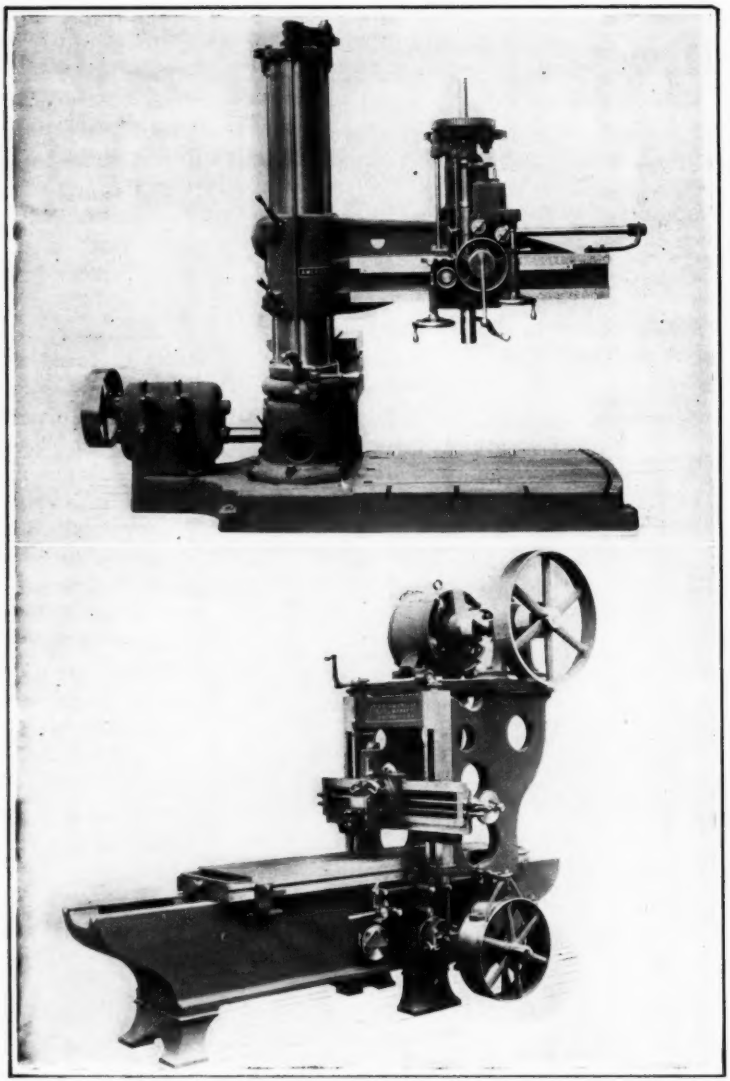


COMBINED REAMER AND FACING TOOL, INVENTED BY MR. WALTER BROWN.

tools with brazed cutters is obviously less than that of the other types and it is not uncommon that the first cost, tool for tool, is less than that of the solid carbon-steel type.

The cores in tools of this class may be of any ordinary steel. Open-hearth has been used in some instances with satisfactory results. If the strain be very great, however, as in the case of long reamers or reamers with shanks smaller than the body, the safe course is to use a good quality of crucible steel. Even when so made, such tools have been known to twist off under exceptionally high duty.

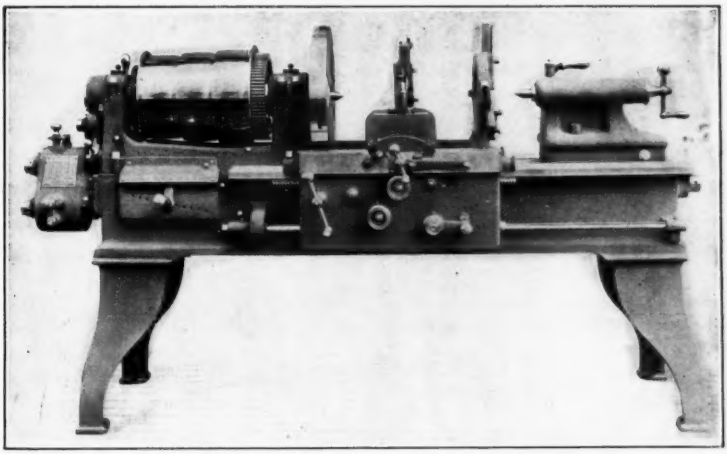
Such tools as reamers and core drills are in certain respects a class by themselves. There is but one way in



SOME MODERN RAPID-PRODUCTION MACHINE TOOLS.

The upper figure shows a plain radial drill with speed-box drive (same as geared head), with ample strength for high-speed work. The lower picture represents a small but heavy planer, motor-driven, with fly wheel to relieve the severe strain in reversing. Both built by American Tool Works Co., Cincinnati, O.

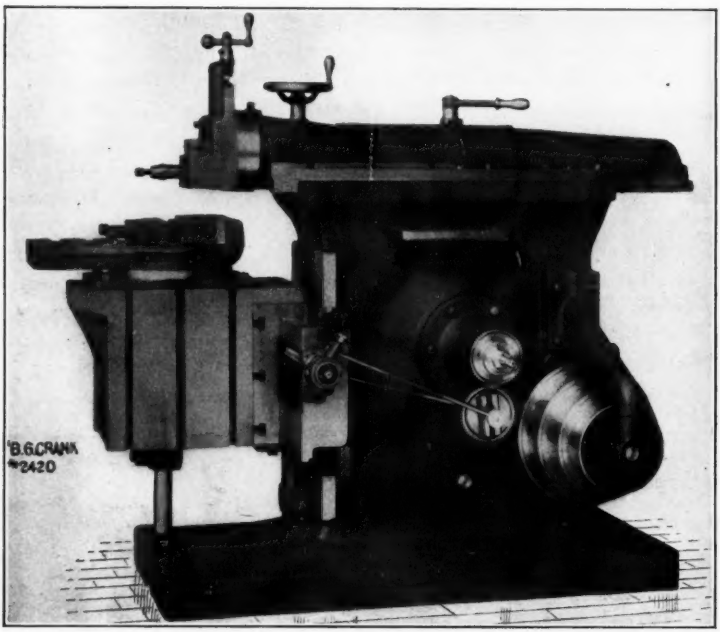
which their work can be kept between the required limits of precision, and that is to keep the size of the tool also within the limits. Now there is always some wear to the sides of cutters, as well as to the cutting edges, so that unless the cutting point be ground back far enough to pass the worn part from time to time, the size of hole gradually becomes smaller and the tool duller—and reciprocally, as the tool dulls more and more the wear increases correspondingly. Of course, the use of high-speed cutters makes such variations in accuracy very slow; and in some shops the matter is considered of small consequence. In other cases, however, it is of considerable importance, and it is desirable to minimize the trouble as far as possible. Expanding tools have therefore come to have a proper place in a shop equipment. Several types have been brought forward, most of them involving the use of mechanically held cutters and taper plugs of one sort or another.



EIGHTEEN-INCH LATHE DESIGNED FOR THE HEAVIEST WORK AND HIGHEST SPEEDS.
American Tool Works Co., Cincinnati, O.

A recent design that gives excellent results and stands up well under heavy duty, has a hollow core slotted at intervals, and the usual taper plug for expanding the cutting end only.

Respecting the design of twist drills little can be said as yet. They are intended mainly for small work, and necessarily their form as developed in carbon steel has come to be about all that could be expected, so that in high-speed steel it will be pretty safe to follow the established lines of design. A recent innovation that will certainly result in a



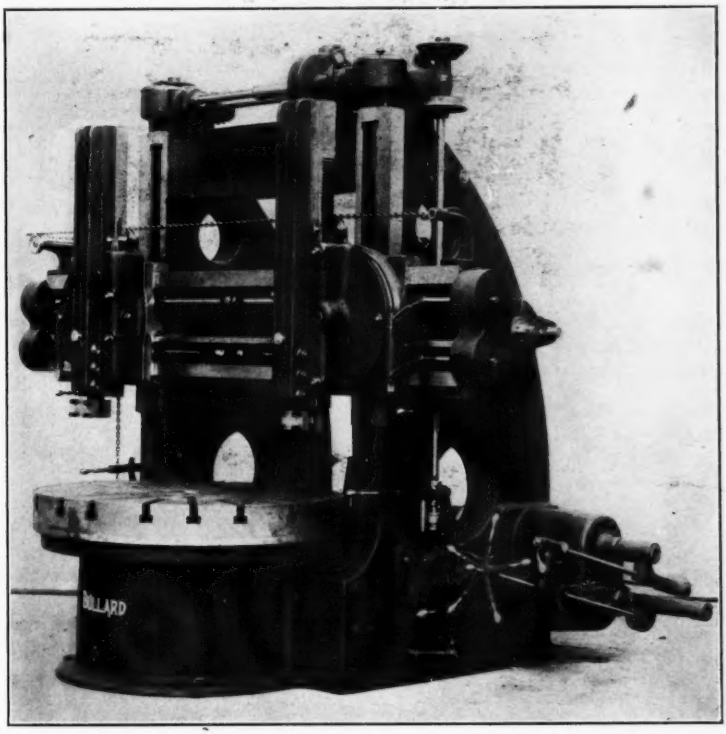
TWENTY-FOUR-INCH "CINCINNATI" HEAVY-DUTY CRANK SHAPER.

Column of unusual width and depth, ribbed and braced internally; ram with wide and long bearing; rail deep, heavy, ribbed horizontally and strongly gibbed to column.
Cincinnati Shaper Co.

greatly reduced cost in twist drills is the introduction by one maker of high-speed steel, of a rod rolled with a fluted section of suitable proportions so that when twisted to the desired pitch it has the standard twist-drill form. Ground to size and cutting edge, and provided with a suitable shank or holder, the drill is complete, at a surprisingly small cost. That these drills are in all respects satisfactory is evident from the fact that they are used almost exclusively by one of the largest manufacturing concerns in the country. The same maker also rolls sections suitable for making other tools in a similar manner.

An important element in tool design—one that does not usually receive the attention it merits—is the angle to which the cutters are ground. It is not unusual in shops said to be pretty well managed to grind tools without much regard to the angle, and quite certainly without regard to the material on which they are to be used or the diameter of the finished piece. It does not appear that reliable

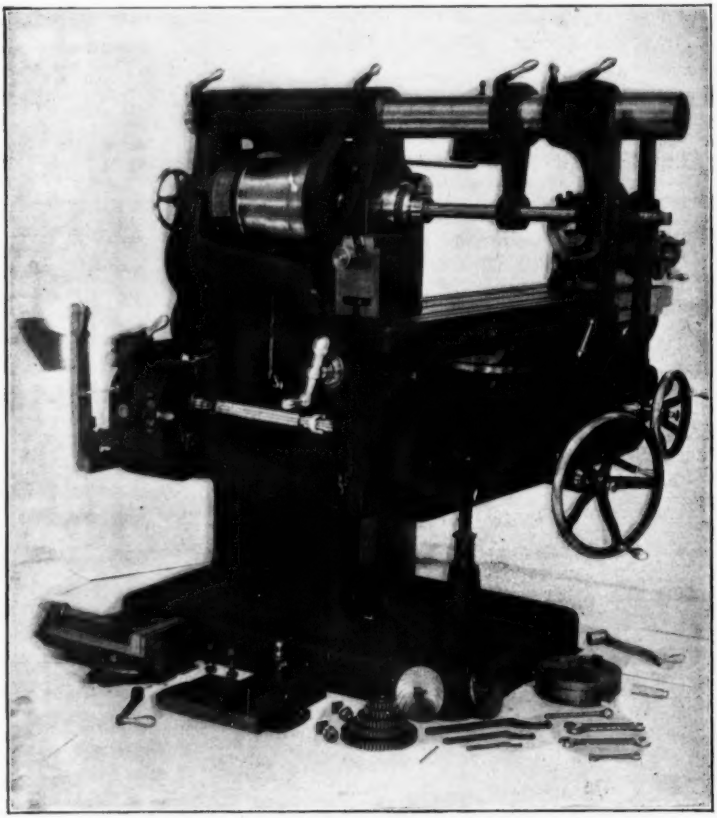
data have as yet been found experimentally upon which to base cutting angles for high-speed tools, though in several quarters experiments have been begun with a view to determining the reciprocal relation of angle to material, speed, feed, depth of cut, and (in the case of rotating pieces) the diameter of the work. Much of this information is already available as regards tools working at ordinary speeds; but there seems to be good reason for believing that at the high speeds possible with the new tools somewhat different angles will tend to greater efficiency. The investigations lately undertaken by Prof. Breckinridge at the University of Illinois School of Engineering should be watched with interest by tool designers.



BULLARD FIFTY-FOUR-INCH RAPID-PRODUCTION BORING AND TURNING MILL.

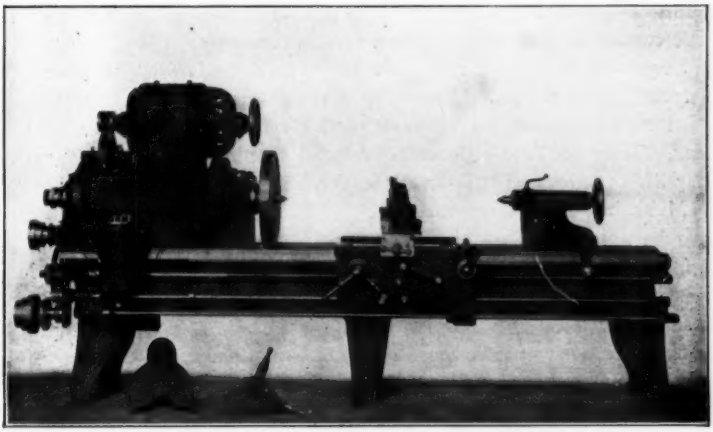
Driven from constant-speed shaft, with fifteen changes by speed-box; headstock and speed-box entirely enclosed, with splash system of lubrication; gears running in continuous bath of oil; ring or chain oiling for all high-speed shafts.
Bullard Machine Tool Co.

Thus far in the present discussion only cutting tools have been considered. The usefulness of alloy steels for such tools as dies, punches, and shears is demonstrated as unquestionably as for the cutting tools. As a matter of fact, however, comparatively little use has as yet been made of them for these purposes, perhaps for the reason that the chief effort of makers of high-speed steels has been directed to the perfection of their product for cutting tools, and in consequence the difference in efficiency between carbon- and alloy-steel shear blades and punches is not so marked as in the case of the



UNIVERSAL MILLING MACHINE FOR MODERN HIGH-SPEED PRODUCTION.

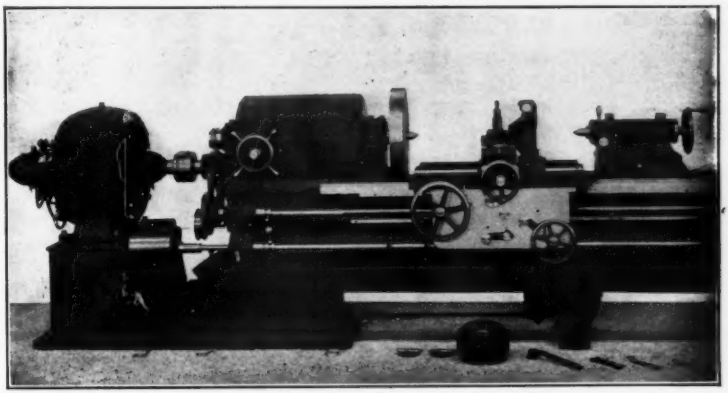
Special features adapting it to rapid production are the unusual width of driving belt, large diameter of driving cone, positive gear drive, and generally heavy and well proportioned design. Becker-Brainard Milling Machine Co.



TWENTY-INCH ENGINE LATHE OF RECENT DESIGN.
Made by F. E. Reed Co., Worcester, Mass. Variable-speed motor and speed-changing gears.

other class of tools. The advantage is obviously in the longer life of the tool and not in any increased speed of production.

No particular variation from the accepted forms has been found necessary for punches of alloy steel. And since the amount of metal required is comparatively small, no attempts have been made, so far as reported, to combine an inexpensive body with a high-speed-steel cutting face. Some successful combinations of this sort have been used for cutting-off shears, and there is no apparent reason why tools

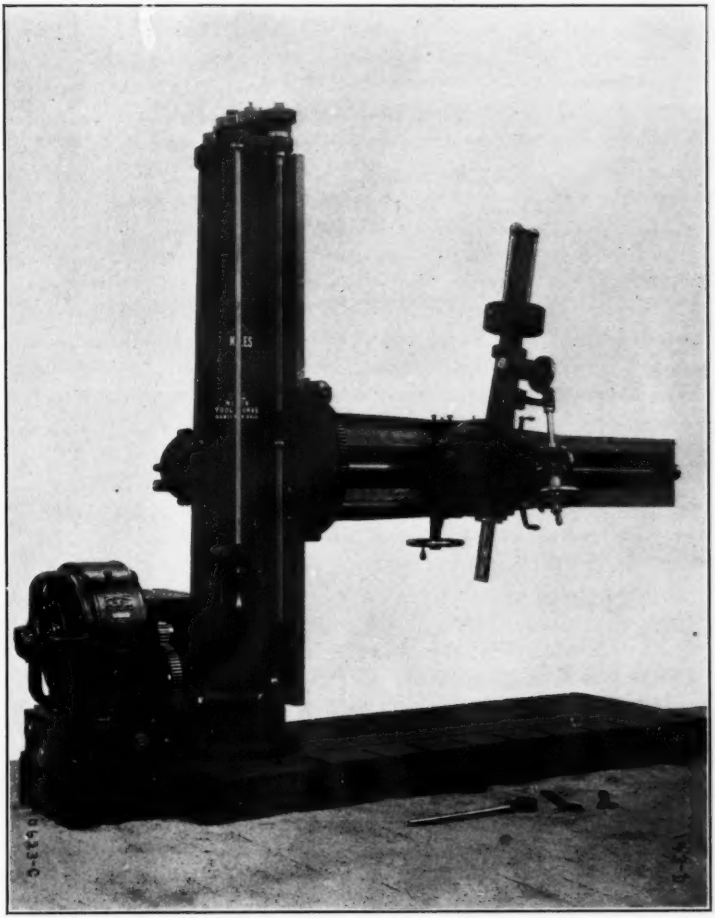


LODGE & SHIPLEY HIGH-SPEED LATHE, DIRECT MOTOR-DRIVEN.
Lacking some of the traditional lathe features; motor armature connected to main gear shaft; speed variations by gears and variable-speed motor.

of this design should not be largely used. Punches having relatively large cutting-face areas would come into the same category.

Some use has been made of the high-speed steels for dies, usually designed upon traditional lines. It is a matter of surprise that high-speed steel is not more commonly used for dies subject to excessive wear. They are but little more difficult to make than others, and their life is out of all proportion to the increased cost.

Much has been said within the short time that high-speed steels have been in use respecting the machine requirements of the new *régime*. Manufacturers of both carbon and alloy steels say that they are systematically reducing their stocks of the former and increasing those of the latter, to conform to the changing trade demands. A logical inference would be that the machine-tool market would be sympathetically affected, and workshops begin to be equipped with machines designed with particular reference to obtaining the highest possible degree of efficiency from the new tools. Visits to factories and selling agencies are however sadly disappointing in this respect. Apparently managers of producing plants are in the main still content to use up their old equipment. For example a large plant employing some ten-thousand men, whose output involves about the maximum in repetitive work, has not as yet installed a single machine that is capable of using high-speed tools to their limit. Neither are any considerable number of the machines in use adapted to secure best results. A few new machines of somewhat heavier type than those previously bought have been installed, and old machines merely speeded up a bit and used at an efficiency usually much below even their present capabilities. In a recent visit to practically all the large selling agencies in Chicago less than half a dozen machines of any type were found in stock that would fulfil even very moderate up-to-date requirements. Any number of the old familiar types could be seen, a few of them slightly modified to the extent of some increase in weight of frame or bed. In most of these, even, there had been no provision for any considerable increase in power, the narrow, many-stepped cones of the ancient yesterday being very much in evidence. A glance through the advertising pages of periodicals devoted to the machinery trade likewise emphasizes the curious conservatism of buyers and makers of machine tools in this respect. It is true that some machines have been made and installed capable of driving high-speed tools to the limit. Usually, however, they have been used for special purposes; and leaving out of consideration the tendency to increase weights, there seems to be little evidence that there is as yet any general move-



A POWERFUL SEVEN-FOOT RADIAL DRILL, DIRECT MOTOR-DRIVEN.
Made by the Niles-Bement-Pond Co.

ment looking toward the substitution of machines of a type in any essential regard different from those put out during the past ten years. An inquiry into the design of machines for use with high-speed tools therefore should take into consideration the adaptation of present types as well as the determination of new ones of greater efficiency.

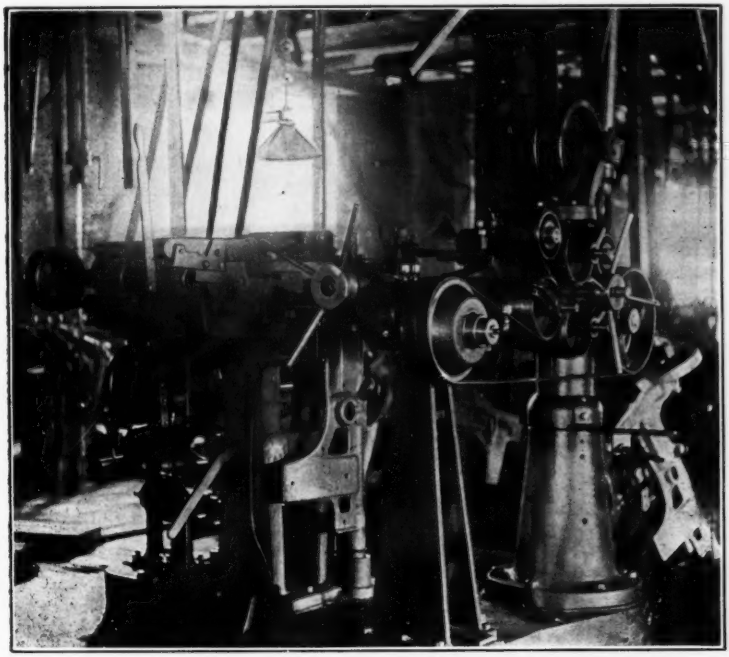
Just what can be done with a machine of the usual type, say a

lathe, is not easy to determine off-hand. Most manufacturers do nothing but speed it up a bit by using the smaller cones more freely, and possibly by adding somewhat to the feed, when using high-speed tools. The average bed is strong and rigid enough to stand more of this than the belt will pull, on short stock at any rate if not on long. An obvious expedient, as pointed out in a previous paper, would be the substitution of cone pulleys with wider faces. Very likely such a modification would suggest the further advantage of discarding the head altogether and using a new one designed with heavier bearings. This is feasible in many instances when the lathe is used for general manufacturing in repetitive work held in jigs, where there is ordinarily nothing to a head but bearings, shaft with cone pulleys and center, and face plate. In the regular engine lathe or turret machines the expense of such a modification would be prohibitive. If the bed lacks rigidity, of course the matter is ended so far as that machine is concerned.

Many machines in general manufacturing shops doing much jig work were designed to take the heaviest work probably to be done in the shop, and are therefore much heavier than required for most of the work done on them. In such cases no modifications will be necessary beyond adaptation of countershafts and possibly driving cones to the heavier pulls and higher speeds.

Now what are the fundamentals of design as affecting machines expected to develop the highest possible efficiency?

Before attempting an answer to this question it is pertinent to point out that this discussion will be looked at from very different viewpoints by the two classes of machine users to whom it might be expected to be of interest. The requirements of the shop doing little but the reduplication of pieces in great numbers which need be "good enough" only, will be very much simpler and perhaps less exacting than those of the general jobbing shop where a machine may be called upon to perform a great variety of work. In the former the use of the jig and similar devices to hold the piece operated upon and to guide the tool, for a large proportion of the work, makes possible a satisfactory use of machines fulfilling but two requirements: strength and power to pull the work. Even extreme rigidity is not usually necessary in this class of work, though by no means undesirable. The small range of work done on any machine not only eliminates the need for any considerable number of speed variations, but actually makes such a variety something of a nuisance. Furthermore, for work of this nature the highly specialized machine is coming to be more and



A VERY HIGHLY SPECIALIZED MACHINE, DESIGNED FOR SPEED AND POWER.

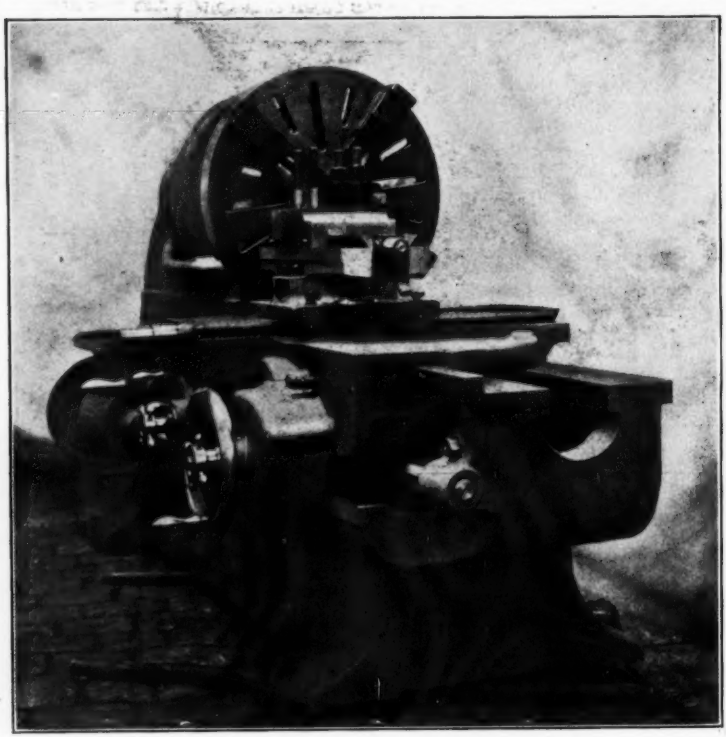
Eleven high-speed drills operate on a special casting from both sides simultaneously. No other job is done on this machine.

more used, its work being limited (for the sake of the highest possible efficiency) to a single piece, or at the most of a few very similar pieces. For all such a single speed is all that it ever used.

Manifestly the shop turning out a few pieces only of a kind, and doing a great variety of work, whether it be the tool room of a big factory, the general manufacturing shop, or the small jobbing shop, requires a very different class of machine. Since jigs will be little used and usually precision must be obtained by accuracy in the machine, there will be the additional requirements of great rigidity, adjustability, and speed variability. In the following discussion the latter class of machines has been most prominently in mind, though much of what is said applies with equal force to the former.

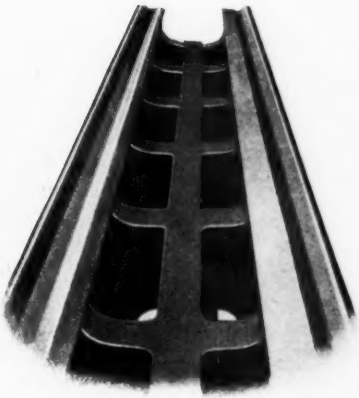
Much has been said and not a little written about the so-named "anvil" as opposed to the "fiddle" principle. The gist of it all appears

to be that solidity, that is to say weight, is the prime essential. Of course mass does create inertia, and likewise rigidity. The proper distribution of material however is more important than the amount of it. It is well known that the hollow cylindrical form of construction is stronger in every way than the solid, for the same weight of material, and this principle is made use of in many ways—in nearly every



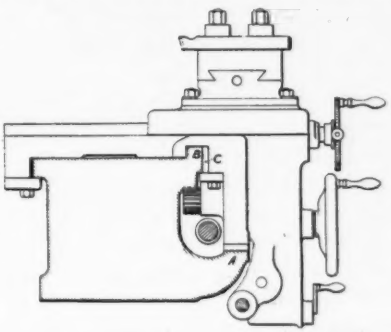
A GOOD EXAMPLE OF ENGLISH LATHE DESIGN.
Made by Darling & Sellers, Ltd., Keighley. Double-tier bed with projecting ledge.

way, one might almost say, except the construction of most types of machine tools. The lathe bed, for instance, still is of the traditional type, namely two I beams housed at the ends and usually stayed by cross girts; and makers are clinging to this form with all the tenacity of a dogged conservatism. It has been shown experimentally (by Professor John E. Sweet, if memory serves aright) that a four-sided box is more than twelve times as rigid with respect to twisting strains



LATHE BED USED ON LODGE & SHIPLEY MACHINES.

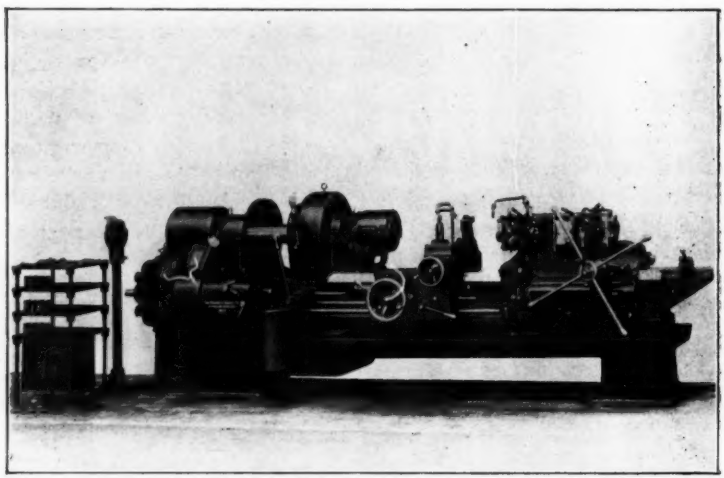
as the same amount of material in side plates with cross girts of the usual proportions. The best possible distribution of material in this form (beams and girts) does not reduce the disproportion more than half (see the diagram on page 409); so that the very best design of lathe bed on conventional lines would have anywhere from one-fourth to one-eighth of the strength it might have were the material distributed in the four-sided box form. Now the chief business not only of lathe beds, but of the frames of all machines designed for rotating work or tools, is to resist such twisting strains; and it might seem that designers would seize upon so simple a mode of saving metal, or rather of getting the maximum strength out of the metal used. As a matter of fact, however, machines of such design are almost unknown—in the United States at any rate. One American maker is said to make a lathe with such a bed, and at least one English manufacturer also approximates the box form. In multiple mills, planers, and lathes, beds and frames or rails having a three-sided (that is, three of the four sides of a box) section are not so uncommon, but this form is scarcely so strong in resisting torsion as the regular type, and only about a tenth as strong as if part of the metal used were distributed so as to make a fourth side.



SECTION THROUGH DARLING & SELLERS LATHE BED AND CARRIAGE.

Next to the body of a machine in importance is the head. Obviously it ought to be in strict proportion with the former. It needs strength and rigidity (and certain other qualities as well)—just as

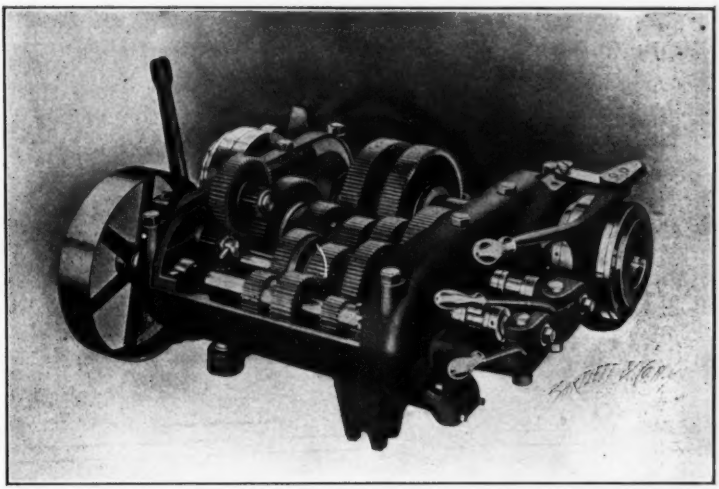
much as the body does—but no more. Certain makers have taken to putting abnormally heavy heads upon regular machines, more particularly lathes, and offering them as up-to-date high-speed machines. These megacephalous monstrosities ("hydrocephalous" somebody has dubbed them, possibly in reference to their designers rather than to the machines themselves) doubtless serve a useful purpose. There is however no more reason for putting a tremendous head on a machine without a corresponding modification in other respects than there would be in using a big tool without proper support. The head of the new machine will doubtless be larger, and certainly heavier than heretofore, not alone to give additional weight, but to admit of modifications in bearings, and mode of driving.



WARNER & SWASEY CO. HEXAGON TURRET LATHE.

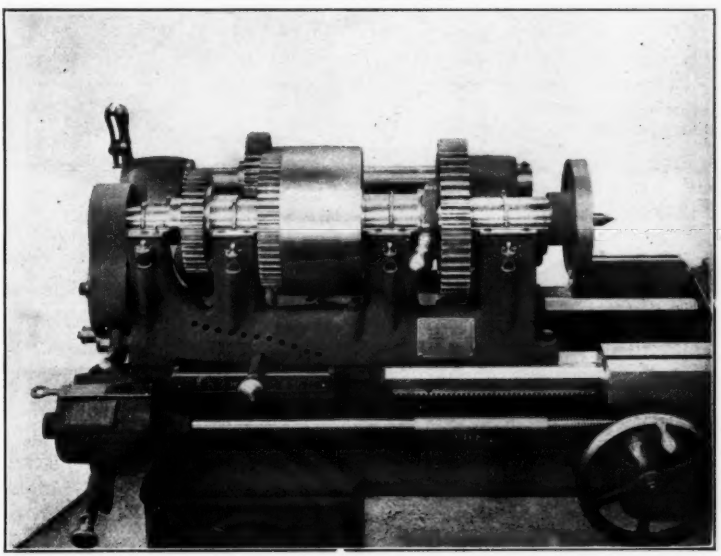
Known as their "No. 3." Head and bed cast in a single piece; direct-connected motor drive; flat turret carriage.

Rigidity and strength being the watchwords of the coming *régime* in machine-tool design, it is pertinent to inquire how this end is best subserved in the attachment of head to body. Except only in a few machines of special design whose utility lies in the range of work of which they are capable by reason of movable and adjustable heads, the driving heads are stationary and bolted to the frames or beds as rigidly as possible. Now if the contiguous faces are sufficiently large, the bolts heavy and numerous, and a good cement used on the faces, an attachment can be made that will be exceedingly rigid. But no amount



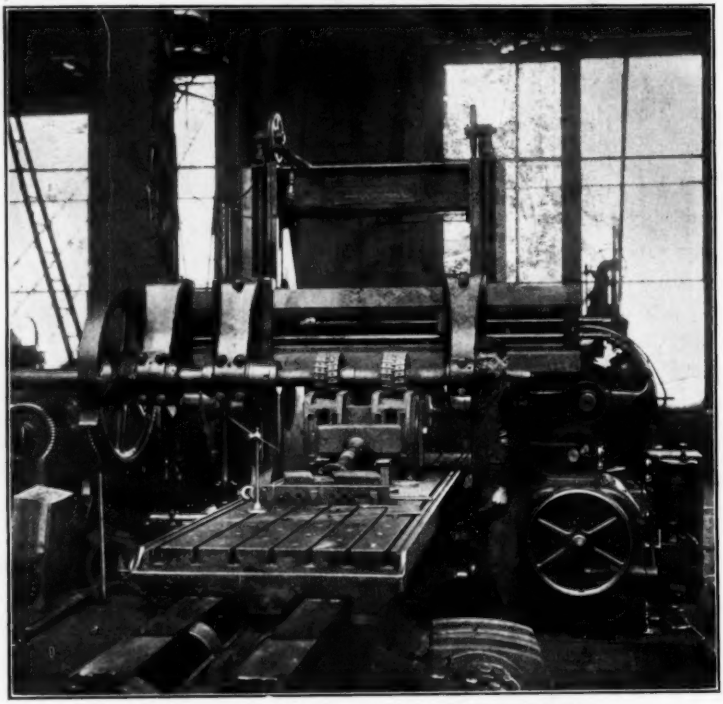
HEADSTOCK OF JONES & LAMSON FLAT TURRET LATHE, WITH COVER REMOVED.

All shafting and gears in a horizontal plane and half-submerged in oil. Single drive pulley and self-contained speed-changing device.



"PATENT HEAD" OF LODGE & SHIPLEY HIGH-SPEED LATHE, WITH CAPS AND SPINDLE REMOVED.

Belt-driven, through a single wide-faced pulley; speed changes secured by gears and countershaft; positive lubricating device.

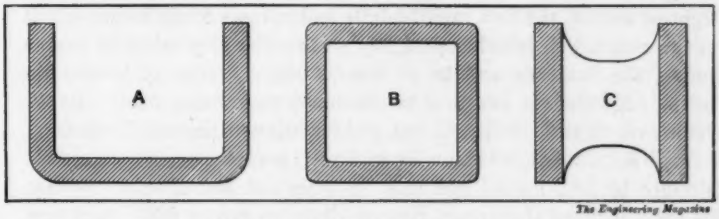


AN EXAMPLE OF MODERN MILLING-MACHINE PRACTICE.

Forty-eight-inch Bement horizontal milling machine at work milling shoe and wedge grooves in driving boxes, Angus shops of the Canadian Pacific Railway. Made by Niles-Bement-Pond Co.

of bolting can take the place of continuity of structure; and it would seem that a head cast in one piece with the frame would be most desirable for high-duty machines. At any rate some builders are accepting the principle in their latest productions, and others are seriously considering doing the same, in spite of the considerably increased foundry and machine-shop cost.

Properly proportioned main bearings are much more important under the new order of things than formerly. Not only is the highly increased speed of the driving spindle to be considered, but also the very large increase in pressures. To meet these conditions bearings require greater surface. It is preferable to have the augmented surface result from increased diameter rather than from length on account of considerations of space as well as rigidity. Such an arrangement



VARIOUS DISPOSITIONS OF EQUAL AMOUNTS OF MATERIAL IN STRUCTURAL SECTIONS.

C is girded at intervals. B has 10 times the torsional resistance of A, and from 6 to 13 times that of C, the precise ratio depending on the strength and frequency of the girts.

permits also the use of hollow driving spindles, which again tends to greater strength and permits the better use of gears in the driving mechanism. In ordinary machines the matter of lubricating the bearings is not troublesome. Under the new conditions it is not so simple however, as everyone knows who has used a standard machine at high speeds. The tremendously increased friction makes it necessary to provide free and certain lubrication for the bearings and therefore involves the design of special lubricating devices for this purpose. A successful arrangement of this sort is shown in one of the illustrations. Oil is stored in a well with which the bearing is provided, and is dipped and carried in sufficient quantity to the highest part of the spindle at every revolution. Glass tubes inserted in front and properly protected serve as level indicators. Another satisfactory device, also illustrated, consists in arranging all shafting and gears in a horizontal plane in a shallow covered pan, allowing all to be at least half submerged in oil.

The tail stock of a lathe used for work turning on centers is little less important, if any, than the head stock, though usually it seems to be little considered. The base is usually rather short, and often it lacks weight. For high-speed work it is more than desirable that there be some provision for positively bracing it against the bed. Obviously the center in the tail stock should be of high-speed steel.

The more joints the less rigidity. Heretofore much attention has been given to securing a great variety of adjustments in the mechanism used for holding and applying the tool to the work. The result has been that slide rests and devices of similar purpose have been constructed of many pieces and a multiplicity of motions. These may have been well enough suited to former conditions; but they certainly are not to the new ones. Rigid support of the tool is vital to its own life as well as to the excellence of the work it does. If there is spring

enough to allow a tool taking a fine cut to ride over the work to the slightest extent, the tool rapidly dulls and refuses to do its work. If on the contrary it is held up rigidly so that the chip takes its proper course, the tendency will be to wear a slight concavity behind the cutting edge and the tool thus be constantly sharpening itself. Be the frame ever so stiff, if the tool rest and its adjuncts permit of vibration, it avails little. Now vibration in cutting is not necessarily perceptible. It might be, and indeed generally is, supposed that absolute rigidity has been obtained if no chattering or vibration can be felt. As a matter of fact however there is no such thing as absolutely preventing vibration in a cutting machine. The most that is ever done is to reduce it to a minimum: that is, to such a point that the work turned out is of the required degree of precision. Often when the operator supposes the machine to be cutting with great ease and smoothness there is really enough vibration seriously to affect the endurance of the tool, if not the required accuracy of its work. To obtain such freedom from vibration the tool-holding and applying device should be of the fewest possible parts, wide base, and least permissible altitude from points of support. That it should be heavy goes without saying.

When cutting speeds are moderate and chips correspondingly easy to care for, these latter cause no concern. When however they come off so fast, as was the case in certain tests made some time ago, that the machine operator needed to exercise a good deal of agility and caution to avoid being tangled up in and burned by the hot chips and two men were kept busy keeping the machine clear, the question cannot be disregarded. The case mentioned was of course an extreme one; but even so it points out one of the limitations which conservatism in machine design imposes upon the performance of the new tools. The removal of several hundred pounds of cuttings in an hour, as is not uncommon, clearly indicates the necessity for some suitable means to collect and take care of them. There is no inherent difficulty in the way of doing so, and in many cases it will be necessary to do it in order to get to the highest limit of efficiency in tool and machine. Nobody seems as yet to have thought enough about this feature of the general problem seriously to attempt its solution by devising a suitable arrangement for mechanically conveying such cuttings away.

The momentum of machines of this class is so great that they usually continue running for some time after the power has been disconnected. It is therefore very desirable that they be provided with some effective form of braking apparatus.

The driving of the high-speed machine presents a number of

problems also. The many-stepped cone pulleys of the past are manifestly impossible for lack of room. Neither are they otherwise desirable. The higher speeds imply not only broader but swifter belts; and changing a rapidly running belt from one cone to another is both difficult and dangerous, unless indeed the difference between the steps be very small—which only complicates the problem again by further multiplying the number of cone steps. The single drive pulley and the variable-speed gear box seem to offer the best solution for the problem. The convenience with which the motor drive can be substituted for the belt, where the latter is not insisted upon, adds greatly to the practicability of gears for speed variation. The difficulty presented in finding space for a sufficient number of gears to give the required range of speeds is not so great as might be supposed. The high-speed tool allows so much latitude in speeds that there is no longer (if indeed there ever was) any necessity for a great number of speeds on a machine of a given size. Furthermore, the tendency is to specialize more than ever in the use of machine tools, so that the range of speeds required of any one machine need not be considerable. At any rate the use of a variable-speed countershaft or motor in connection with (say) about three speeds in the gear box, will give a range of speeds amply sufficient for most machines.

Objection may be made to the use of gears that they are too positive and in heavy pulling liable to breakage. Gears have already practically superseded belts for pulling the feeds in the ordinary type of machine and the same objection could be made to the use of gears for this purpose, for the strains on the feeding mechanism are as great proportionately as on the drive. The use of steel gears and possibly shearing pins obviates any difficulty on this score that might arise from objectionably large iron ones.

The advantage of the individual motor drive for machine tools is coming to be pretty well understood. High-speed tools and machines, with their greatly increased consumption of power, emphasize more and more the disadvantage of line shafting. The greater speed and power per machine unit necessitates greater weight and speed in the line shafting and belts, and increases the amount of power lost in transmission—a loss considerably greater than the supposed increased expense of maintaining motors. Evidence of the recognition of this is found in the constantly increasing sale of motor-driven machines of all sorts.

Though there is substantial agreement as to the advantage of the electric drive, there is great diversity in practice in bringing the motor

and machine into practical relation. The practice varies all the way between the use of an independent motor driving through a direct belt or indirectly by way of a countershaft, to the mounting of the rotating armature directly upon the main driving shaft. Undoubtedly the latter is the most economical mode of hitching, since it avoids belts, chains, or intermediate gears. It almost necessitates one or more variations in motor speed however—which is not particularly a disadvantage. Usually the method is to attach the motor to the machine at some convenient place and make the connection in one of the ways already mentioned. Aside from the difficulty of avoiding torsional strains where motors are attached by brackets or additions to the frame, it is desirable to have the two adapted to each other as closely as possible so that the highest efficiency of each may be developed. It appears now as if progress pointed in the direction of such an intimate combination of the two that the motor becomes an integral part of the machine, as it would be if the main driving spindle of the latter were also the spindle of the former. Whether such an arrangement is practicable for all the different types of machines may be open to question. Experience has shown that it is in the case of lathes. If there should be practical difficulties in the case of other types, there is no good reason why the type might not be changed or re-designed to meet the new conditions. As in everything else, the traditional strongly influences machine design, and it requires a good deal of courage to break away from convention. Thus the lathe is essentially what it has been from the year one. It is true several forms of machine have been developed out of the lathe, but these also have undergone modifications very slowly.

There is a pretty well-marked tendency in the metal trades toward a greater use of machines making use of the rotary principle and a corresponding disuse of the reciprocating. In other words, the planer, shaper, and slotter are losing ground before the much more efficient milling machine in its several forms. Doubtless it will be a long time, if indeed it ever comes, when the reciprocating tools will be entirely obsolete, for there are likely always to be jobs to which the rotary cutter can not be well adapted. However that may be, it is a proper subject for congratulation that ways are being found to eliminate to a large extent the wasteful reciprocating action and to substitute for it the comparatively efficient rotative movement.

In conclusion, it may be worth while to consider briefly another aspect of the high-speed-steel problem, namely the power consumed in the drive.

Increasing speed, as is well known, rapidly uses up power. The standard machines have been using comparatively little per unit, rarely as much as a single horse power, and except only in machines built for very great power, never as much as two. But the newer machines consume rarely less than three or four horse power, and frequently several times as much. At high speed and with heavy cut, a twenty-inch (swing) lathe has on occasion used up a maximum of thirty horse power, though its average consumption was less than ten, and the minimum a good deal less still. Obviously the amount of power used depends mostly upon the amount of metal removed in a given time, and it does not necessarily follow that because a machine eats up power rapidly it is therefore wasteful. As a matter of fact it is demonstrable that efficiency at high speeds is very much greater, considered on the basis of units of power consumed alone, than at the lower. In other words, on the basis of metal removed and time consumed, the new machines and tools use considerably less power than the standard-speed machines. This paper is already too long to go into details in the matter. It is sufficient at present to point out that under favorable conditions the power required per pound-hour of metal removed varies from 0.03 to 0.07 horse power, which is measurably less than is required under similar conditions with less powerful and speedy machines. A fuller discussion of this subject is intended in a later paper.

EDITORIAL COMMENT

WE have steadily maintained that every engineering problem of the Panama Canal offers a complete solution, the fuller and more satisfactory the farther the study is pushed; and that all the embarrassment which has so far attended the work has sprung from climatic conditions which have been again and again met and practically neutralized in constructive work elsewhere in the tropics, and from administrative and bureaucratic obstructionism which has always appeared in every undertaking executed directly by the Government. Mr. Waldo's article, which is taken directly from the field notes and the personal journals of some of the parties working on the Isthmian surveys, is a remarkable demonstration of all these points, and is given the leading position in this number on account of its importance to an issue of great present National importance. It is further significant in that the Gamboa Dam project, for the first time adequately presented in the "Appendix" to Mr. Waldo's article, is the key to the sea-level plan said to be favored by a majority of the Advisory Board.

The danger in the situation on the Isthmus, of course, is that when the annoyances of red-tape are combined with the physical discomforts of the country, the destructive effect on the economy attained and on the *morale* of the workers rises as the product—not merely as the sum—of the injurious factors. Mr. Waldo's article is presented in the spirit of wholesome criticism, which holds not the slightest doubt of final success in the building of the Panama Canal, but feels that that result will be soonest and most safely reached by arousing a lively sense, on the part of the Administration and the people, of the only present conditions impairing the progress or the prospects of the enterprise.

* * *

AT the time of our going to press, the Advisory Board of engineers, called together to recommend a decision as to the type of canal to be constructed on the Isthmus, have held what is regarded as a final session upon the choice of type, and the result is widely and no doubt correctly announced—eight to five in favor of the sea-level plan. It is further credibly reported that the majority group is made up of the five foreign representatives and Messrs. Burr, Parsons, and Davis, leaving the minority consisting of Messrs. Noble, Randolph, Stearns, Ripley, and Abbot again divided into two parties favoring two variants of the lock type.

It is most unfortunate that if the Board were unable conscientiously to agree upon a verdict substantially unanimous, anything at all should have been made public until the majority were able not only to declare their position, but to support it by so convincing an exhibition of engineering necessity or of reasonable argument that public opinion would be consolidated immediately behind it. So many interests—honest and otherwise—are lining up against the Canal, or preparing to make the Canal the mask for an attack upon the Administration in the coming Congress, that it is deplorable to have popular support perplexed and scattered by a verdict which does not seem to be projected forcibly enough to overcome the resistance opposed to it.

We believe much of the disappointment may be removed by the full statement of the Board's conclusions. Particularly, it may be shown that in the matter of time needed for construction, the sea-level and the lock projects are much more nearly equal than is commonly supposed; this would go far, we believe, to allay the disappointment now expressed. It would be better the country should know more, or that nothing should have been made public. As it is, let us hope an adequate abstract may be ready in time for the President's message—if, indeed, the agreement of the Board to disagree is final.

* * *

It was publicly known in advance of the first convention that various members of this Board were openly recorded in favor of at least three types. Yet the hope of a substantial majority agreement was not unreasonable, whatever may have been the prior differing opinions of certain members of the Board. No commission had heretofore been able so to concentrate its study of the question within perfectly definite and close lines. No preceding commission has had anything like the fund of data presented to this Board—data which in part are said to throw new light on crucial points. A review of the whole case in the light of new evidence might well modify a preceding verdict.

There is one deduction plainly to be drawn from a divided report, if that should be the outcome of the Board's deliberations. It is simply that there are several plans fully feasible, and that one or other of them has appealed most to the individual judgment of the several members as one or other element of the problem (construction, maintenance, operation, cost, or time required) has impressed him as carrying the greatest weight in the solution. We emphasize this because it is the direct contrary of the fallacious deduction which will be shouted forth by the enemies of the Canal. If the Board is not unanimous, it means *not* that the problem is insoluble, but that it has several solutions, each sufficiently meritorious to attract the approval of one or more of the members.

Let us hope one may prove to have such commanding merit that it may justly receive the acceptance of all friends of the undertaking.

* * *

The term "engineer" has been variously defined, from the oft-quoted statement of Tredgold that he is one who "directs the great sources of power in Nature to the use and convenience of man" down to the modern one of Wellington, defining him as the man "who can do for one dollar what any fool can do for two dollars." Both of these, and indeed any definition which can be framed as well, must include the idea that the engineer is an economist. He directs the sources of power in Nature to economical advantage; or, if he does not, he will not save the odd dollar, and hence be no better than any other man, so that the old definition and the new one are not greatly different in principle after all.

Viewed in this light it seems rather curious that engineers, in various countries, should have taken so long a time to appreciate the fact that the business side of engineering work is really included in their professional bailiwick. In this country the desirability of including commercial and economic questions in the work of the engineer has been appreciated earlier than elsewhere, and more than one railroad president has developed from the engineering department into that of administration. The American professional societies have taken an early part in the discussion of questions relating to the administration of industrial work from the business side, and the various scientific methods of re-

munerating workmen, determination of costs, and solution of the numerous problems of works management, have had their inception or their strongest impetus from the members of the engineering profession. In fact, the so-called business men, familiar with the commercial side of engineering and manufacturing only, have often been eluctant to accept methods devised without regard to the ancient precedents derived from mediæval methods of trade, and it is only with the active entrance of the engineer into the affairs of business administration that modern conditions have been taken into account in a scientific manner.

* * *

On the Continent this question of the discussion of economic subjects by professional bodies of engineers is just beginning. A circular, issued by the Bavarian Section of the Society of German engineers (the largest body of engineers in the world, publishing as Transactions one of the most valuable technical periodicals in Europe), has recently been issued stating that, after due consideration, it has been thought well for the members to contribute to the transactions papers upon related industrial matters. Members are asked for their opinions upon such subjects as the value of economic studies to the engineer, the function of the production engineer, the influence of technology upon general culture, the effects of industrial combinations upon manufacturing industries, scientific methods for the remuneration of labor, the value of engineering statistics; and these and numerous related questions are proposed as suitable subjects for contributions and discussions. Other questions suggested are those including the combination of economic matters with those usually considered as wholly technical. Thus: the influence of the practical applications of the science of thermodynamics upon public prosperity is shown to be important; the development of methods for the use of liquid fuel has a distinct relation to the location and conduct of manufacturing enterprises; the development of automobile vehicles, both for personal and industrial service, is destined to work economic transformations. These and many other subjects of related character are included in a programme mapped out with characteristic German thoroughness, and doubtless destined to cause the publication of many valuable studies.

* * *

In this Magazine it has long been maintained that the economic side of engineering demanded a full share of attention, and reference to the contents of past volumes and numbers, notably the special issue upon Works Management, will show the valuable articles upon the various branches of the subject which have appeared in its pages. Methods of cost keeping, of shop accounting, stores keeping, and engineering administration in all departments, in the field, in the shop, and in the mine, have been discussed; and we believe that we are fully justified in maintaining that the interests of engineers, superintendents, and managers have been more fully and completely set forth in this Magazine than has been attempted elsewhere in any periodical publications. That the largest engineering society in the world is now seriously and formally declaring these subjects to be within the domain of its discussions and transactions, is a gratifying acceptance of a policy always held of controlling importance in the pages of The Engineering Magazine.

REVIEW OF THE ENGINEERING PRESS.
"THE WORLD IS ITS FIELD"

THE ACCESSIBILITY OF PORTS.

A REVIEW OF THE CONDITIONS GOVERNING THE ACCESSIBILITY OF HARBORS FOR MODERN MERCHANT VESSELS.

Brysson Cunningham—Engineering.

IN response to the continually increasing demand for improved facilities the art of the engineer and of the marine architect has produced vessels of greater and greater speed and cargo carrying capacity. While progress in these directions will doubtless continue, it is generally understood that the limitations surrounding the further development of shipbuilding are not those with which the marine architect can cope directly. The dimensions of modern vessels are being more and more controlled by the limitations of the ports which they have to enter, and this question is becoming one of such importance that a paper by Mr. Brysson Cunningham upon the accessibility of ports, published in a recent issue of *Engineering*, is altogether timely.

Mr. Cunningham reviews rapidly the great progress which has been made in dimensions, powering, and speed of merchant vessels in recent years, and then proceeds to show that further advances must depend largely upon the facilities provided for entering ports, questions belonging mainly to the province of the dock and harbor engineer.

The considerations which exercise the most influence in determining and limiting the accessibility of a port may be grouped under four heads: location; environment; the approach channel; and climatic conditions; and these Mr. Cunningham discusses in order.

The question of location is taken to cover the geographical situation of a port, whether on the sea coast or on the banks of a navigable waterway, and with this may also be considered the second point, viz., that of environment.

So far as mere location is concerned, it is manifest that a position on the seaboard offers distinct advantages over one approached by a river, and this latter situation is being continually placed in a worse plight as the dimensions of vessels increase. Mr. Cunningham compares the ports of Marseilles and Havre on one hand with those of Antwerp and Bremen on the other, emphasising the important and expensive works which the Belgian government is being compelled to make, an outlay of 183 million francs being estimated as necessary in order to maintain the accessibility of the port of Antwerp.

Considering the matter of environment, a seaboard position has serious drawbacks, these being mainly those due to exposure to weather. Many ports of the seacoast have been made available only by the construction of costly protective works, such as massive breakwaters, to enclose areas of tranquil anchorage. Natural harbors, with sheltered bays are not unknown, and such examples as Queenstown, Sydney, San Francisco, and Rio de Janeiro are cited, but in many such locations there are attendant difficulties from tides and currents, with their accompanying bars and shallows. River ports have also their difficulties, due to the evils of silting and the growth of vegetation, and in these matters the relative importance of the various drawbacks must be decided for each situation.

"We now come to the third point. The most potent of all the factors governing accessibility is the nature and profile of the entrance or approach channel. Trade will accrue and cling to a particular route, no matter how lacking it may be in natural conveniences, provided it be equipped with a navigable waterway. In fact, whatever other advantages and disadvantages may attend a port, the approach channel is, *de facto*, the censor and measure of its potentialities. It governs the size and class of vessels entering or leaving, and it regulates their speed and the time of their movements. It acts with relentless precision, and its fiat is irrevocable.

"At the same time it has certain redeeming qualities. It is generally capable of treatment and amelioration. Its bed may be improved, widened, deepened, straightened—and so made more serviceable and less obstructive. That this is the case is indeed fortunate, for there are few ports where works for the regulation and improvement of the entrance channel have not been, or have not become, an urgent necessity. In fact, it may be said that some of the most thriving and successful seaports of the present day exist and flourish in spite of obstacles to navigation which would have baffled and daunted any but the most determined and persistent attempts to remove them."

In considering the vital matter of the approach channel, Mr. Cunningham takes the case of a typical modern freighter, intended to trade with a number of ports and having an average load-line draught of 30 feet. Such a draught cannot be considered as excessive, since the average load-line draught of 50 modern steamers touches 31 feet, but it appears that with a 30 foot draught there are but three ports which can be considered as invariably open, these being Marseilles, Genoa, and Tacoma, all on the sea coast and all having a negligible tidal fluctuation. By observing slight tidal restrictions, such a vessel could reach New York, Quebec, San Francisco, and Southampton with fair regularity, and also penetrate the Mersey as far as Liverpool, and the Thames as far as London, but in all other cases the period of access is stringently limited, if not absolutely non-existent.

A load-line draught of 30 feet will doubtless soon be considered very moderate, and the fact that this is appreciated in New York is seen by the active conduct of dredging works to provide a 40 foot depth in Ambrose channel. Such considerations must also have great weight in the plans for ship canals, and doubtless the final plans for the Panama canal will take into account the demands of the merchant cargo vessels of the impending future.

"We come now to the final item on our list. Climatic conditions and natural phenomena may be favourable to the accessibility of a port or they may not. In the latter event they will be found to embrace a variety of impediments to navigation, most of which, at present, at any rate, are largely outside the sphere of human influence. Fog, storm, and frost constitute a formidably maleficent combination, dispensing danger to the navigator, inconvenience to the shipowner, and loss to the merchant. Vessels have arrived within the immediate vicinity of their destination only to be fogbound, or tidebound, or icebound, for periods to be measured in some cases by hours and in some cases by days. Quite recently the Baltic reached the mouth of the Mersey in the early evening, having made the trip of 3,000 miles across the Atlantic at the rate of something like 17 knots, or 450 miles a day. Owing to a dense fog, complicated by low water, the remaining 18 or 20 miles to the Liverpool landing-stage consumed a full 12 hours—a delay as costly as it was vexatious, in that the mail train could not leave for London until noon of the following day. Much valuable time was thereby irrecoverably lost, and the inconvenience caused to business men must have been incalculably serious.

"An incident of this kind, however, assumes an air of trifling importance when compared with the ordinary experience of certain ports in northern latitudes during the winter months. The harbour of Montreal, for instance, is closed by ice, as a rule, from the last week in November till late in the following April. The Baltic ports are almost equally unfortunate; even Boston and New York are not exempt from the inconveniences of frost; and though shores laved by the Gulf Stream are generally free from obstruction, it is little more than ten years ago that the River Mersey

was packed with dense masses of ice drift.

"So far as fogs are concerned, nothing apparently can be done at present. The matter is receiving attention at the hands of scientists, and at least one remedy has been suggested; but its range of application is too restricted for it to be capable of anything like universal benefit. Conceivably, in time, some means will be discovered for dispersing wholesale the intangible folds of November's deadly shroud, but the day seems distant as yet.

"Ice, on the other hand, yields to mechanical agency. The late Admiral Makharoff and others have done much to develop and perfect the ice-breaker, especially in Russian waters, where its need is most felt. Yet it is strange that the appliance has not gained greater popularity. There are still a number of ports which submit to the iron grip of winter without an effort to maintain their communication with the open water. Such ought not to be the case at the commencement of the twentieth century and it cannot long be permitted to continue.

"Reviewing the subject as a whole, it will be seen that there is undoubted necessity and ample scope for the progressive treatment of all ports, especially in regard to their entrances and approach channels. Developments take place nowadays at so rapid a rate that any lethargic or fatalistic indifference to the trend of modern ideas and requirements must inevitably be attended by speedy retribution. As is the case with all industrial communities, it is only by keeping abreast of the times that ports can maintain their vitality, or hope to increase their prestige and importance. Vigorous measures, therefore, and a judicious outlay (commensurate, that is, with the resources and prospects of the place) must be held to constitute the essential features of a sound policy in maritime affairs."

THE VENTILATION OF TUNNELS.

PRACTICAL METHODS OF MAINTAINING FRESH-AIR SUPPLIES TO THE RECENT ALPINE TUNNELS UNDER CONSTRUCTION.

Karl Brabbée—Zeitschr. d. Oesterr. Ingenieur u. Architekten Vereines.

IN order to meet the demands of traffic and railway extension there has been a continual advance in that department of engineering devoted to tunnelling, and in the Alpine regions of central Europe especially there is much activity in such undertakings. The older tunnels are passing more trains than ever, and no sooner is a new one completed than plans are made for other and more ambitious borings. In connection with such works the problem of ventilation is a most important one, not only as a part of the operative scheme of the completed work, but also as an essential element in the satisfactory conduct of the boring and clearing of the passage.

It has been estimated that in long tunnel works the power required for satisfactory air supply to the workmen is greater than the total of all other demands for operative machinery, drainage, hauling, etc., so that the relative importance of the subject is apparent. In a paper recently presented before the Austrian Society of Engineers and Architects, and published in several issues of the *Zeitschrift des Oesterreichschen Ingenieur und Architekten Vereines*, Herr Karl Brabbée examines this subject of ventilation of tunnels, and although his investigations relate principally to the modern methods of supplying air to the workmen during construction operations, the general principles developed are of value.

Although the boring of the Simplon tunnel has been already effected there are even now four important Alpine tunnels under construction, namely the Bosruck, Tauern, Karawanken, and Wochein tunnels, and in all of these there are important mechanical plants in operation.

In the light of the practical experience gained in these and other similar undertakings, Herr Brabbée has conducted a number of experiments upon the flow of air under working conditions, and in the absence of any generally accepted system of tunnel ventilation these investigations assume an especial interest.

The earlier method, adopted in most of

the long Alpine tunnels, and still in use in connection with the eastern portion of the Arlberg tunnel, is that of forcing in air through comparatively small pipes under a considerable pressure. On the western side of the same tunnel a departure has been made from this plan to the extent of using somewhat larger pipes, this permitting the desired volume of air to be supplied by ordinary fans. This is a step toward what must be considered the correct principle, that is, the supply of a large volume of air, through conduits of large diameter, and at low pressure. The best example of this principle is seen in the Simplon tunnel, in which the auxiliary tunnel itself constituted the air-supply main, and indeed the late engineer, Brandt, expressed himself as of opinion that this feature constituted one of the most valuable elements in the adoption of the twin tunnel scheme.

In examining the performance of a tunnel ventilating plant there are three subjects to be considered: the motive power, the blowers, and the conduits through which the air is driven.

So far as the motive power is concerned, the use of electric motors is now so general that no other need be considered. While the question of the best form of blades for fan blowers cannot yet be assumed as entirely settled, this was not made a subject of research in the investigations under consideration, a standard type of pressure blower being employed in all the experiments. The real matter for experimental determination was to find the volume and pressure necessary at the beginning of a conduit of given length and diameter which should insure the delivery of the required volume of air at the other end. The problem may also be stated as the determination of the loss in the conduit, being in this respect similar to the allied question in electrical engineering, the loss of current in an electric conductor.

Experiments and formulas for the loss in air conduits have not been lacking heretofore, and Herr Brabbée cites twenty references, dating from 1824 down to the present, and representing the work of many noted engineers, but upon plotting the results of the formulas thus given wide differences appear in the results; two only approaching the mean result obtained by averaging all of them, and the curve being a very irregular one. Under these circumstances it was thought advisable to conduct a series of experiments upon riveted conduits of various diameters in actual service, to determine the loss due to reduction in diameter, and to find out the influence of working and atmospheric conditions upon the efficiency of ventilating pipes.

The apparatus employed is described in detail, consisting of a modified form of Robinson anemometer so arranged as to be inserted in the main through a small opening, and adjustable so as to enable the velocity to be determined either in the middle or near the wall of the pipe; the temperature, pressure, and humidity of the air being simultaneously taken. By arranging a number of test points at different parts of a main the gradual change could be determined in a manner enabling curves to be plotted, and in the original paper numerous curves constructed from the observations are given. We can give here only some of the conclusions deduced, as bearing upon the general question.

The studies involved some 600 separate tests, these being weighed carefully according to the conditions under which they were made and 492 being taken as fairly representing the actual facts as closely as could be ascertained. They included measurements made upon pipes of 300, 500, 700, and 800 millimetres in diameter, or say ranging from 12 to 30 inches, in lengths of 300 to 900 metres, or say 1,000 to 3,000 feet, so that the scope of the investigation may be considered as ample.

The first result of the tests was to establish the fact that the coefficient of friction of the air in the mains was practically constant for pipes greater than 500 millimetres, or say 20 inches, in diameter, being equal to 0.0175 for velocities from 4 to 17 metres per second; but rapidly rose for smaller diameters. The loss in pressure was found to depend upon a certain coefficient similar to that found in connection with the flow of water in pipes, and upon the coefficient of friction, which, as above noted, is constant for constant conditions of size, state of air, and kind of pipe. The formula deduced by Herr Brabbée appears to be a pure parabolic function of the velocity, provided the specific gravity of the air and the length of

the main remain constant. Assuming a specific gravity of 1.2 kilogrammes per cubic metre, and a main of 200 metres in length, Herr Brabbée plots the results in curves for diameters from 300 to 800 millimetres, these showing the action very clearly.

In actual practice it is recommended to use a large pipe, that is, above 500 millimetres in diameter, for the principal part of the main, reducing this to about 300 millimetres as the working headings are approached, in order to diminish the liability to loss from deformation due to explosions in blasting, etc.

The diagrams accompanying the investigations are of much interest, and the whole forms a valuable contribution to an important engineering question.

ASPHALT PAVING CONSTRUCTION.

A DISCUSSION OF THE CONTROLLING FACTORS IN THE CONSTRUCTION, MAINTENANCE, AND COST OF ASPHALT PAVEMENTS.

Andrew Rosewater—League of American Municipalities.

IT has been said that the beginning of asphalt pavements was made in Paris by Napoleon III., because the stone blocks previously used provided too convenient a material for the construction of barricades in times of revolution. Be that as it may, there is no doubt that this very desirable form of pavement has come into use in countries where the barricade question did not enter, and in the course of the half-century since the *coup d'état* the use of asphalt has become very general.

In a paper presented before the League of American Municipalities by Mr. Andrew Rosewater, the subject of asphalt paving construction is discussed at length, and in view of the fact that there are now in the United States some twenty-five hundred miles of streets of such paving, covering about forty-four million square yards, the importance of the question is manifest.

Mr. Rosewater discusses at some length the history of the subject in the United States, with especial reference to the matter of monopolies and competition, and shows that at the present time there are a number of sources of entirely reliable material, and that the proper way to treat this side of the question is for the municipal engineer to prepare careful specifications for himself, and place the work in open competition, subject to proper engineering supervision.

"In asphalt, as in all other pavements, the first essential to good, durable construction is a proper base. A good earth road requires, first of all, proper drainage, both for surface and sub-surface. The solution of this feature is a simple engineering proposition. The next essential is consolidation—the more compact, the less will the surface yield to vehicle traffic, and the greater is its durability. The fact that earth yields readily to the softening and dissolving influence of water demands a very high crown upon an earth road that it may shed water as fast as possible to escape its softening agency. The fact that it partly dissolves when wet makes a soil yield more readily when porous because these voids will quickly absorb, or fill with the dissolving agent; hence the more compacted and less porous, the less it will be exposed to moistening influences.

"Again, if the earth roadbed is subjected to water from beneath the surface, it will not only be undergoing constant change in the summer period, but when winter comes the water, when freezing, will expand and heave up the surface. With these fundamental principles outlined, we next come to the pavement proper.

"Divested of all verbiage, a pavement is a veneering or wearing road surface. It is placed there to protect the base and give it durability. The early attempts at pavements were of the old Roman road order, consisting of layers of large blocks of stone in mortar, which distributed the load over a much wider area than that directly exposed to the tires of the wheels. These roads have numerous variations, such as slabs of granite laid in parallel rows for the wheels to run on; tram railways, with iron or steel surfaces distributing their loads through the medium of ties or planks to the earth surface; the macadam roads developed about 100 years ago, with depths

of broken stone, varying with the traffic, and depending for their efficiency upon compacting the aggregates, first on the traffic, which took years, and later upon great road-rolling machinery, which crushed and forced the various aggregates to a wedged and compact mass, developing a smooth surface."

Mr. Rosewater considers the factors of a good asphalt pavement to be a good sub-drained compacted base, upon which rests an intermediate monolithic material, with a covering of asphalt having a wearing capacity capable of meeting all traffic conditions and resisting the destructive action of temperature changes and climatic influences. The intermediate material he considers best made of Portland cement concrete, of sufficient strength and thickness to transmit the load uniformly to the earth beneath.

Taking up the question of the asphalt covering as the matter under consideration, there are certain requirements which it should meet to be considered satisfactory. Thus: the asphalt covering must be compact and hard enough at all times to meet traffic requirements. It must not be readily affected by water, it must be durable, retain its smooth form, and not become slippery. These requirements mean that the component elements of the covering must be such as to become a solid, voidless mass that can resist the compression of traffic, and expansion and contraction of temperature extremes.

"Experience has shown that asphalts from Trinidad, Venezuela, California and numerous other sections of the country, 60 per cent. of whose bitumens are soluble in boiling naphtha, possess sufficient adhesive cementing qualities to make a proper paving cement. Experience has further developed that the actual and necessary quantity of bitumen thus soluble to make a proper paving mixture shall range between the extremes of 10 and 13 per cent. by weight. The exact proportion will vary between these figures, dependent upon the nature of the sand grains and voids in the sand. The specifications should, to insure good results, provide that not less than 10 per cent. of bitumen shall be required in the mixture. This does not mean 10 per cent. of asphalt, for what is known as refined asphalt varies in the degree of refinement. Bermudez, Venezuela or California asphalts are, when refined or manufactured, free from sand or other mineral mixtures, and, therefore, contain from 95 to 99 per cent. pure bitumen. The Trinidad asphalt, as refined, contains fine, impalpable mineral powder to the extent of 36 per cent. In the latter case it requires more asphalt to produce the 10 per cent. of bitumen, but, on the other hand, the amount of filler of stone dust or Portland cement required with this asphalt is proportionately less than with the others."

Mr. Rosewater shows that the common method of comparing asphalts according to the amount of bitumen they contain is erroneous and objectionable, since 10 per cent. of extracted bitumen must be added in any case. To exclude asphalts containing less than 90 per cent. bitumen is to exclude some of the best materials in the market, while admitting others of inferior quality. Municipal interests are best subserved by providing specifications calling for open competition as to asphalts, and asphalts of requisite quality can best be obtained by providing for the minimum of bitumen in their mixtures subject to the boiling naphtha test, which determines the malthene or petrolene components which constitute the cementing quality of asphaltic bitumen.

Taking up the question of the sand, which forms 90 per cent. of the asphalt covering, Mr. Rosewater calls attention to the varying grades of natural sand, and states that the problem of determining the best grade of sand for pavement purposes is still only partially solved. The best results appear to be obtained by substituting finely ground Portland cement in place of stone dust, and by specifying about 12 per cent. of cement excellent results will be secured at a cost of only a few cents per yard over sand.

"The history of municipal growth has shown it impossible to avoid constant cutting up and otherwise disturbing the paved surfaces of urban streets. Water-works construction, sewer construction, gas construction, and telegraph, electric light, telephone and other conduits of every kind are brought into demand with each new discovery and each new construction, and the

problem of finding a pavement that is permanent is as unsolvable as the squaring of the circle.

"The only feature of permanency existing in public works is that of permanency of repairs. In connection with asphalts, as well as other pavements, the economic lines are along those of prompt attention to the repairs before the cuts are enlarged by traffic. Twenty years of close observation of municipal conditions leads me to the conclusion that every city should have a plant and an organized corps of skilled men to attend to the maintenance and repair of its paved streets. Once equipped with the best of modern appliances, streets can be kept in a condition of continuous repairs at the minimum cost. To do this the construction and engineering departments must be divorced from partisan politics and placed under a permanent system of civil service."

So far as cost goes, Mr. Rosewater gives a division of the different departments of a pavement, showing that the concrete base represents 38 per cent. of the total cost, and the asphalt covering about 29 per cent., the balance being divided among the costs for excavation, superintendence binder, and miscellaneous items.

SINGLE PHASE ELECTRIC TRACTION.

SALIENT FEATURES OF SINGLE-PHASE ELECTRIC TRACTION AS APPLIED TO STREET RAILWAY SERVICE.

Charles F. Scott—American Street Railway Association.

THERE has been much talk of late about the merits and demerits of the single-phase electric motor as applied to traction purposes, and while various practical applications have already been made there is room for a better understanding of the system by those interested in traction matters. For this reason the paper presented by Mr. Charles F. Scott before the American Street Railway Association, upon the single-phase railway system is of especial value at the present time, and demands attention and review. Naturally the comparisons which are made are between the continuous-current motor, now so generally in use for electric traction service, and any other which it is proposed to substitute for it.

"The radical difference between railway systems using direct-current motors and those using single-phase motors is not so much in the car or the power-house as it is in the circuits connecting them. In the first place the high voltage used on the trolley wire does away with expensive feeders and it also enables the current to be carried to a greater distance from the power-house or from the substation. Second, the substation employed in the single-phase system requires simply a lowering transformer. The substation for supplying a direct-current railway requires the rotary converter and a set of lowering transformers. Third, the number of substations for a single-phase road is less than is required for direct current and these do not require the attendance which is necessary for the operation of rotary converters. It is these characteristics that peculiarly adapt the single-phase system to interurban and long-distance railways."

Mr. Scott emphasises the fact that a satisfactory motor is not all that must be realized to make a single-phase traction a success, but that the system must be completely worked out as a whole. This includes the design and construction of control apparatus adapted to the new conditions, and available for small cars and for heavy multiple-unit equipments. Transformers, line switches, and other auxiliaries must be designed, and combined with suitable overhead construction adapted to the current and voltage conditions, and it is a whole system, and not the mere design of a motor, which must be considered in referring to the question of single-phase traction either for street railways or for interurban service.

"In how far have the advantages claimed for the single-phase system been realized? Among the important features are the following:

"A high-voltage trolley construction has been developed and has proved to be simple, strong and thoroughly practicable.

Thirty-three hundred volts has been used and has proved to be safe and reliable.

"A sliding contact device which does not require reversing when the direction of the car is changed is found more satisfactory, especially for high-speed operation, than the trolley wheel. Its wearing surface lasts longer than trolley wheels operating lighter cars on direct current.

"Transformer substations supply current satisfactorily without feeders and without station attendants.

"The car equipments show simplicity and effectiveness in the control apparatus. Less than half the controller notches required for direct current give equally smooth and as rapid acceleration with alternating current. Platform controllers are simpler as no magnetic blow-out is required. The unit control system is readily adapted for the operation of single-phase motors and is in some points simpler than the control of direct-current motors.

"The operation interchangeably by alternating current and by direct current is a feature of an important road which operates large equipments on direct current in the city and on alternating current across country.

"Motors of four or five sizes have been built and show excellent commutating features. The commutators take a good polish. The motor windings are such that there is a practically balanced magnetic pull, even if the armature be slightly out of centre. Although the armature speed is higher than in corresponding direct-current motors, the advance criticism has proved ill-founded as there have been no bearing troubles. The oil lubrication has proved highly satisfactory.

"The foregoing features, which are the important elements upon which the claims of the single-phase system are based, have been shown by actual operation to be entirely feasible and practicable, and such as to inspire confidence.

"Difficulties have been met which have been annoying and vexatious. The difficulties, however, have usually been due to some error in the general features or to some specific point of weakness in the insulation or construction of some part of the apparatus. In other words, the troubles have not been fundamental and inherent in the single-phase system, but have been incidental and capable of ready remedy."

There are some misconceptions about the advantages of the present continuous-current motors in use which Mr. Scott clears away, and a right understanding of the points is of material assistance in examining the advantages of the single-phase system. Thus, it is generally supposed that the continuous-current motor is a variable speed machine, but in fact it is, fundamentally, a one speed motor, the speed depending upon the voltage, and only variable from this normal speed by the use of resistances, a wasteful and temporary method, or by the use of more than one motor, permitting operation in series or in parallel. The limitations of the continuous current motor in this respect are well seen by examination of the various efforts which have been made to secure a satisfactory speed control for motors used in operating machine tools in workshops.

It is well understood that satisfactory speed control involves effective voltage control, and this desideratum, not efficiently attainable with the direct current, is easily secured with the alternating current.

"The simplest method of variable voltage is by means of taps from the transformer winding. The low voltage required for starting is obtained from a low tap and the successively higher voltages for increasing speeds are secured from successively higher taps from the winding. As there is no rheostat the motor may run efficiently from any tap, thereby giving the motorman a control over his car movement which is not possible with direct current."

Mr. Scott refers to the successful behaviour of the single-phase system in practical operation, citing especially the equipment of the Indianapolis and Cincinnati Traction Company, which has been operating more than thirty-seven miles of road for nearly a year.

Other shorter lines are also in operation with success, and plants now under construction include 150 miles of railway running south from Spokane, Washington, and also single-phase locomotives for hauling the passenger trains of the New York, New Haven & Hartford Railroad Company into New York City.

CORROSION OF STEAM BOILERS.

THE INFLUENCE OF CORROSION IN THE PRODUCTION OF FURROWS AND GROOVES IN BOILER PLATES.

Ch. Frémont and F. Osmond—Revue de Métallurgie.

AMONG the causes of the deterioration of steam-boiler plates one of the most insidious is the corrosive action to which may be attributed the grooving and furrowing so frequently observed in cases of failure. The manner in which these injurious and weakening grooves are formed has been a matter for discussion for a long time, and no very satisfactory theory has been advanced to account for the peculiar way in which corrosion appears to produce furrows as deep and straight as if they had been produced by a cutting tool.

In a recent issue of the *Revue de Métallurgie* this question is examined by MM. Fremont and Osmond, and the extent to which their views agree with the results experienced in practice renders their discussion an important contribution toward the solution of this obscure problem.

When a sheet of iron or steel is exposed to the action of air and moisture it becomes oxidised more or less rapidly. This oxidation is effected principally by the carbonic acid which is present, since the free oxygen which may be present has only the power to raise to a higher degree of oxidation any protoxide which may be already in contact with the metal. Since the various conditions of temperature, pressure, chemical composition, etc., remain constant in the case of a given boiler, any irregularity of the rate of corrosion must be sought in the original variations in the structure, or in the unequal conditions dependent upon construction or service of the various parts. In general the irregularities in corrosion of boiler plates may be divided into two classes, pitting and grooving. The isolated regions of corrosion known as pittings consist of separate cavities, apparently due to independent causes, although occasionally uniting or merging into one another as their area is extended. Grooving, on the contrary, consists of distinct and continuous furrows, resembling the scoring effects of a cutting tool, this action being generally observed along seams or other parts of the boiler which are subjected to flexure in consequence of the stresses caused by service.

There is no doubt that the origin of these forms of corrosion may be partly attributed to the condition of the metal due to the treatment received in the course of manufacture. There are also various shocks and effects of fatigue under pressure which must be taken into consideration, and the manner of corrosion is undoubtedly influenced by all of these considerations.

Local pitting is probably caused, in most instances, by local variations in the constitution of the material, the presence of sulphur, manganese, slag, etc., forming points of attack which yield more readily to the action of the acid than do the homogeneous portions of the metal. Probably the lack of homogeneity also permits the formation of local electrical currents, facilitating an electrolytic action of more or less definite character.

The peculiar action of grooving, however, demands another explanation, and it is to this subject that the paper of MM. Frémont and Osmond is devoted. The noticeable feature about grooving in steam boilers is its localisation, so to speak. The furrows are generally found running parallel and close to the riveted seams, and as long ago as 1863, in the report of the Manchester and Midland Boiler Association it was described in this significant manner: "Furrowing along a seam of rivets, or rather under the line of an overlap, is found to be the usual malady."

This localisation of the furrowing action leads to the idea that it must be connected in some manner with the structural details of the boiler, in connection with the conditions of its operation. In general, observations upon furrowing in boilers show that this effect appears in nearly every case at places where there is a change in the thickness or strength of the material, or where, from the form of the parts, there is a localisation of surface stress. Follow-

ing out this lead, MM. Frémont and Osmond have shown a very reasonable explanation for the manner in which grooved corrosion is produced.

Under ordinary conditions, with a uniform and homogeneous material the oxidation of a metal plate should proceed uniformly over the entire surface, covering it with a layer of oxide of equal and continually increasing thickness. In a steam boiler, however, there are conditions which prevent this uniform action. A boiler is subjected to varying pressures and stresses, and these cause continually changing flexures and deformations of the various parts. A flue or shell, riveted up of plates, is not truly cylindrical, however carefully it is made, and the notable departures from true circular section appear at the riveted seams, where the lap of the plates and the thickness of the metal occur. Even with butt joints and cover plates there is a marked change in thickness of metal at the seams, and the same is true, although to a smaller degree, with welded seams. As a consequence of these structural requirements the flexure stresses in the plates are greatest at or near the seams, and although this localisation of stress is not extreme, it is frequently repeated.

When, therefore, the interior of a boiler becomes covered with a thin layer of oxide, this layer is not permitted to remain as a continuous coating, but is broken, or cracked at the points which are subjected to the greatest stresses and flexure, the oxide itself being very brittle and almost wholly incapable of resisting deformation. These cracks and fissures in the general layer of oxide uncover surfaces of clean metal, permitting renewed and vigorous action of the corrosive elements present, and a slightly deeper effect is produced along the line of the break in the oxide. Like many other actions, this tends to extend itself, since the first localisation of the corrosion renders the metal slightly weaker along the line of its direction, rendering the next flexure still more sharply defined in the same place, and causing a fresh surface of metal for corrosion to be exposed, so that the furrowing action continues indefinitely.

This theory is found to be fully sustained when the portions of the sheets under consideration are subjected to microscopic examination. In the paper of MM. Frémont and Osmond there are given reproductions of a number of microphotographs, all tending to confirm the fact that any action which produces unequal surface stress is liable to cause increased oxidation, in the form of grooving and furrowing.

MM. Frémont and Osmond refer with commendation to the paper of Messrs. Houghton and Rogers, recently presented before the Iron and Steel Institute, but show that their own work was done before this latter communication was made public, both series of investigations, however, agreeing in the main as to the causes of the action under consideration.

TRAINING FOR MINING ENGINEERS.

A DISCUSSION OF THE NECESSARY COMBINATION OF SCIENCE AND PRACTICE IN THE EDUCATION OF MINING ENGINEERS.

Dr. J. B. Porter—British Association for the Advancement of Science.

DURING the recent South African meeting of the British Association for the Advancement of Science, gatherings were held at the more important of the cities visited, papers being read and addresses delivered in various places. Among these addresses one of the most noteworthy was that by Dr. J. Bonsall Porter, of McGill University, Montreal, upon the question of the education of mining engineers. This subject is one especially appropriate for a South African audience, amid surroundings largely related to mining, and in a country where engineering problems of great variety and difficulty have been encountered and solved by the application of modern scientific methods.

After reviewing the development of mining methods, from the crude beginnings of early periods, down to the introduction of modern scientific appliances, Dr. Porter showed that at the present time mining and metallurgical processes are conducted in a manner similar to those of any other

branch of engineering. Haphazard prospecting is replaced by scientifically conducted geological surveys, employing accurate appliances for borings, and following rational industrial and manufacturing methods.

All this involves, or even demands the methodical scientific education of the engineers by whom such work can be done, and it is of this matter of the training of mining engineers that Dr. Porter had chiefly to speak. In so doing he deprecated the idea of early and extreme differentiation and specialization so often undertaken, believing rather that a broad and sound foundation should be laid for the support of future work.

"The same fundamental sciences underlie all branches; the same training in physics, mathematics and mechanics is essential to a true understanding of each profession, and the man who learns these and other fundamental subjects thoroughly, even at the expense of technical training, is far more likely to succeed ultimately in any special work than the man who has received elaborate training in one line, but whose first principles are weak. Furthermore, not one student in a dozen knows, when he comes up to the university, which branch of engineering he really prefers; still less does he know which one he will ultimately practise. Young engineers are no less subject to chance and circumstances than other men; and for this reason, even if there were no better one, we should strive first to make our men engineers, and then only to give them special training.

"The fact that no man can tell in advance what his life's work will be is sometimes used as an argument in favour of a general engineering course, with a smattering of everything. It is true that an intelligent boy who keeps his eyes open will learn not a little of many practical things in connection with his theoretical studies, and an effective method of teaching is to point theory with practical illustration whenever this can be done without losing sight of the main issue. It is, however, a most serious mistake to make a course general rather than thorough, and even a speciality really well taught is better than broad but shallow instruction."

A mining engineer has generally to do his work under difficult conditions, being often alone and obliged to meet many and varied problems and solve them with his own unaided resources. General engineering work and surveying are his daily tasks; simple problems in electrical and mechanical engineering must be disposed of without the assistance of specialists, while a good knowledge of geology, with some mineralogy and chemistry, is absolutely essential. Such conditions require that a certain degree of practical and technical training should form a portion of the education of the mining engineer, and Dr. Porter's views upon this much-discussed feature are of especial value.

"An engineering student, whatever his branch, should undoubtedly do some shop work on the ordinary materials of construction at a very early period in his course. He will not be able to spare time enough to become a skilled workman, or even a half-skilled apprentice, and he must be made to fully understand this; but he can and should work long enough to know something of the use of tools, and to understand the qualities of the materials of construction which he is about to study theoretically. This elementary shop work is often attempted in workshops connected with the technical schools themselves, and frequently the work can be done in the afternoons while regular studies are going on. This method is economical of time, and there are many advantages in having the teaching and shop work under the same direction; but in many cases it is better for the boys to get their experience in ordinary shops, where they should be required to work full time under ordinary shop discipline. In no other way can they be made to realise what work really is; intimate acquaintance with workmen is also very useful.

"This shop work can usually be arranged for the long vacation, which should be long enough to give time for it, and for a reasonable holiday. Two periods of two or three months each should suffice for an ordinary boy, especially as practical technical training is also required at a later period in his course.

"This technical work is even more important, in my opinion, than the shop experience. It should, if possible, follow the general science teaching, and precede the

specialisation. Whenever practicable the student should obtain *bonâ-fide* employment in some works in his chosen speciality, but the exact nature of the work is of no very great moment, so long as it is good engineering work, done by good workmen intelligently directed. The important thing is, again, to get the student in touch with real work and real wage-earners, and to give him an idea of scale. The elementary shop-work may be done, if necessary, at convenient times in a school workshop; but this technical work must be real in every respect. The student should, for the time being, become a plain workman on wages, responsible to his foreman for certain duties, and liable to penalty or discharge for cause.

"The time to be given to the work must depend on circumstances. Three months, under the right sort of foreman, in a small but interesting mine or works will teach as much as a year of ill-directed drudgery. Furthermore, students differ greatly in the readiness with which they take to practical work. Many men are the better students for having had many years of hard apprenticeship; but very frequently the man who has spent a year or more in practice finds it difficult to return to his classes. He is earning money at work, and can often ill-afford to give it up, and again become dependent on his people. Study also often proves irksome, and sometimes very difficult, after a man has been actively employed in work. As a result, many men fail to return to their final studies, and thus lose what should be the most useful part of their education.

"If a definite time for practical experience must be set in advance, it may be said that two periods of about four months each in different works, or one period of a year, would be about right; but in this, as in all other matters of technical education, it is far better to make the regulations somewhat elastic in respect of field work and advanced study. Much time can be saved the students, and their work made more effective, if each case is separately considered by the responsible head of their department."

After a student has passed through this period of practical experience his final studies should be taken up, the teaching becoming more specialized and quite technical, care being taken at the same time to keep fundamental principles in sight. The appliances of the technical laboratory should be freely used, but both in the laboratory and in the lecture room care should be taken to teach principles rather than processes. One or two heavy investigations are far better than many short experiments, and the instructor in charge can often do his men far more good by showing interest and yet letting them work out their own salvation wherever possible, than by being too ready to set up apparatus and smooth over difficulties.

Dr. Porter calls attention to the importance and value of a knowledge of methods of determining costs and making estimates, and while reliability in these departments can come only by experience, it is gratifying to see that he emphasizes the fact that the mining engineer, like every other kind of an engineer, must be a business man also, if he is to achieve success under modern conditions of work.

ACCOUNTING METHODS FOR MINING SUPPLIES.

THE WAREHOUSING AND ACCOUNTING SYSTEM DEVISED FOR THE LAKE REGION IRON MINES OF THE UNITED STATES STEEL CORPORATION.

W. M. Jeffery—Lake Superior Mining Institute.

AT various times we have published and reviewed in these pages articles upon methods of cost keeping and stores accounting for machine works, contractors, and manufacturers, and the subject is one of wide-spread interest and importance. Stores keeping has been brought to a science in many workshops, and from a paper presented before the Lake Superior Mining Institute by Mr. W. M. Jeffery it is evident that excellent progress has also been made in connection with mining work. The organization of the United States Steel Corporation brought together a number of establishments which had previously been operated independently, and it is in connec-

tion with the iron ore mines of this company that the plans described by Mr. Jeffery have been perfected.

"When we take into consideration the fact that our mining supplies constitute approximately 30 per cent. of the cost of producing our ores it is not to be wondered at that operators are deeply interested in the methods of accounting for such a large percentage of the producing cost. The first duty of an individual, a copartnership or a corporation with a valuable asset to be intrusted to the care of an employee is to select a person who has the ability and the honesty to take good care of and account for such asset. A large amount of capital is required to be invested continually in material necessary for the operation of our mines and sufficient material must be on hand at all times to assure continuous operation. It would be false economy, surely, to allow the stock of material in our warehouses to reach a point where operations would have to be delayed awaiting the receipt of material. On the other hand, an excess stock needlessly tying up capital must be guarded against and the oldest stock should be worked off whenever possible to prevent its becoming obsolete.

"To accomplish the result of having our material account well guarded and to keep our investment in material at the lowest point consistent with economical operation some of the mining companies have adopted the plan of general warehouses—that is, where a mining company owns several mines in one locality, although the mines may be separated by considerable distances, they have a warehouse as centrally located as possible, where the entire stock of supplies for all mines is carried. This plan, in the first place, necessitates but one warehouseman with special ability for this work and saves the cost of having a man of this class at each mine. Clerical work of the warehouse can be done by cheaper labor under the direction of this one man. In the second place, this arrangement permits of carrying a smaller stock of supplies than would otherwise be possible. It is unlikely that a similar part of any class of machines will break at all mines at the same time, and one or two spare pieces carried in stock will guard the interests of all mines in the vicinity, whereas separate warehouses, one at each mine under its own warehouseman, would in all probability each have a part for a similar machine, as the warehousemen would possibly not be in close touch with each other. The extent our stock of mining supplies is reduced by the plan of central warehouses can only be realized by one thoroughly familiar with supply work. It may be said in passing that a great saving in the quantity of supplies necessary to be carried can be accomplished by using as far as possible uniform machinery at the various mines. This is especially true in the case of power drills, steam shovels and pumps."

Mr. Jeffery goes into the system of accounting somewhat in detail, with reproductions of the warehouse records and supply cards.

The invoices for purchases are received in duplicate, and checked by the party responsible for the order, and then forwarded to the point to which the supplies are consigned. The duplicate is sent to the warehouse to be returned when the goods have been received, while the original is held by the clerk at the mine office until the receipt of the goods at the warehouse has been certified by the reappearance of the duplicate, so that the coming together again of the two invoices forms a complete check upon the transaction.

The warehouse records consist of a freight receipt book, a box of supply cards, and a supply of debit and credit slips. The freight record book keeps an account of all material received. The supply cards are ruled in ledger form and enable an account to be kept of each grade or class of supplies, one side showing the quantities received, with information as to consignor, quantity, price, and amount, while the other side shows date, account for which supplies were used, quantity, price, and amount. The cost of operating the warehouse is not included in the cost of the mining supplies, but is treated as a separate cost account, just as is office expense.

The charging of the supplies to operating accounts is based upon the price of the oldest supplies on hand until all items of that lot have been consumed, and then using the price of the next lot until they are consumed. The disbursement of the supplies

are recorded by means of the debit and credit slips. No supplies are issued from the warehouse without an order from the superintendent of the properties or some one duly authorized by him; the orders stating the items of the supplies required, and bearing the proper signature. The warehouseman enters on the debit slip the amount to be charged to each of the operating, construction, or improvement accounts, while corresponding entries are made upon credit slips for each class of supplies delivered. The total of the credit slips for a given period must equal the total of the debit slips for the same period, showing that the articles and values charged to the cost accounts agree with the articles and values credited to the supply accounts, while the balancing of the supply cards shows the quantity and value of every kind of supplies on hand. A monthly balance sheet enables a general view of the whole business to be obtained.

"The benefits to be derived from a system of this kind are many. The first that we would mention is the fact that we are enabled to get a correct supply cost on our cost sheets by being able at all times to know absolutely the cost of each article of supplies, because the inventory is so well guarded from leaks of different kinds it is not necessary to add to our supplies consumed a percentage of profits to make up for any possible loss in the handling of supplies. If a cost sheet is to be of any use to an operator it must be accurate; otherwise it is misleading rather than beneficial. Anything therefore tending to improve the cost sheet is of great benefit to the operator who is responsible for the cost of producing ore.

"Next in importance is the benefit of having the supply records in a condition where the warehouseman knows absolutely what he has in stock and can be governed accordingly in making requisitions on the purchasing department for additional supplies, thus keeping down the investment in mining supplies to the lowest point consistent with good operating.

"Another important advantage in a system of this kind is the readiness with which an inventory may be arrived at at the end of the year, or for that matter at any time during the year. All are familiar with the task of taking a complete inventory at the end of each year, when the weather conditions are very unfavorable, when no one knows just how the supplies are going to come out, when the closing work of the year makes it hardest to spare the necessary time and when the time for taking the inventory is necessarily limited. If this system is carried out as it should be and the cards checked continually with the actual material on hand there should be no hesitancy about taking the card inventory at the end of the year as being actual.

THE DISTRIBUTION OF POWER.

PROGRESS IN THE GENERATION AND LONG-DISTANCE TRANSMISSION OF MECHANICAL ENERGY BY ELECTRICITY.

W. E. Ayrton—British Association for the Advancement of Science.

AMONG the valuable and interesting papers presented before the British Association for the Advancement of Science during the recent meetings in South Africa the address of Professor Ayrton upon the distribution of power demands attention, not only because of the importance of the question itself, but also for the brilliant manner of its presentation.

Referring to a lecture given by himself in 1879, Professor Ayrton called attention to the fact that Johannesburg, where he was then speaking, had been founded only five years after, and that the development of practical applied electricity had grown up almost within the same period as had seen the development of the city in which he was speaking. With this growth had come the appreciation of the fact that high voltages enabled electrical energy to be transmitted over long distances with but a moderate loss, and in 1891 it was shown that more than ten times 2,000 volts could be successfully used to transmit more than 100 horse power over more than 100 miles with more than 75 per cent. efficiency in the case of the Frankfort-Lauffen transmission. The explanation of the advan-

tages of high voltages for long-distance transmissions was discussed by Professor Ayrton, showing that the use of higher and higher pressures has enabled larger and larger amounts of power to be transmitted over longer and longer distances, with greater and greater efficiency, that is, with less and less waste. This important fact is examined by Professor Ayrton at length.

"The electric current, as you know, is used for lighting buildings, driving machinery, propelling cars and trains. But throw away the notion, if any of you still have it, that electricity is a kind of gas, or oil, or fuel that is used up in these operations. The common expressions, buying electricity, consuming electric current, are most misleading, for just as much electricity flows away per minute—through the return conductor—from your electrically lighted house as flows to it through the coming conductor. If, therefore, it were electricity that you had undertaken to pay for, you must have made a very bad bargain, because you do not retain the smallest portion of what you would have agreed to purchase.

"The electric current is like a butcher's cart carrying round meat—you no more consume current than you consume cart. It is not the vehicle, but what it leaves behind that the consumers buy—meat in the case of the butcher's cart, and energy in the case of the electric current.

"Exactly the same considerations apply to the distribution of power, with air at 70 lb. pressure per square inch, to the thousands of rock drills on the Rand, to the distribution of power with water at 425 lb. pressure per square inch down the shaft of the Rietfontein Mine, and at 750 lb. pressure in the workshops of the Central South African Railways at Pretoria.

"The energy conveyed with air, with electricity, or with water is made up of three factors—(1) the current, (2) the time during which it flows, and (3) the pressure under which it flows; while power depends on the current and the pressure only."

Naturally the value of the ability of long-distance-transmission of power depends upon the possession of power to transmit, and this includes a clear understanding of the meaning of the term power. In engineering, power has one very definite meaning—the rate of doing work, that is, it includes the time element, so that a high pressure or head, as it is termed, must be maintained over a definite period of time. One of the great advantages of electricity is that it may be employed to transmit the power generated by natural sources of energy, such as waterfalls, to points where they may be used to commercial advantage. The advantage appearing in the use of high electrical voltages is indicated by Professor Ayrton by showing the analogous condition which exists in the case of water power.

"When water has but a few feet of head, the quantity flowing over a water wheel must be large if much work has to be done. But since the water comes to a low pressure wheel along an open stream and flows away again along an open stream, no expense has to be incurred in laying down large pipes. If, however, it were necessary to distribute much power over considerable distances through a pipe conveying such low-pressure water, the pipe would not only have to be long, but of large cross-section, and therefore very bulky and costly."

In the case of water power, therefore, the question of volume and head both have to be considered, and in the case of electrical transmission the corresponding questions of voltage and current are the important features.

Discussing the main subject of the development of power, prior to its transmission, Professor Ayrton examines the possible sources of power in South Africa, including the much-discussed subject of the utilization of the power of the Victoria Falls of the Zambezi river.

"Probably, like myself, you have heard vague comparisons made between the power of the Victoria and the Niagara Falls. Now, what is the true comparison?

"The flow at Niagara varies at different times of the year from about 62 to 104 million gallons per minute. At the Victoria Falls the flow can be as little as one-twelfth of the smaller number—for it is so now; and some authorities, well acquainted with the spot, say that at the end of another three months the flow will only be half of even that. The mean available drop at Niagara is about 160 feet; at the Victoria Falls about 380 feet. Hence, while the

minimum Niagara flow represents about 3 million horse power, the *present* Victoria flow represents about 580,000 horse power, or only about one-fifth of the Niagara flow. Further, if those who predict the flow of the Zambezi sinking to something like 2½ million gallons per minute in November are true prophets, the Victoria Falls will then only give out about 300,000 horse power, or, say, one-tenth of the *minimum* that Niagara produces.

"In all that precedes, I have taken the full power of the direct drop in each case; that is, I have assumed in each case the intake to be close to the main drop, and I have deducted nothing for inefficiency of machinery."

So far as the actual transmission of large quantities of energy over long distances is concerned, numerous examples show us the extent to which this has already been done. Thus, in Italy 3,300 horse power has been sent over 22 miles at 40,000 volts. In the United States distances from 100 to 200 miles are regularly spanned by wires conveying electric currents at pressures of 50,000 to 60,000 volts, transmitting 5,000 to 15,000 horse power, and in one case more than 4,000 horse power is sent over 110 miles by the use of a pressure of 67,500 volts.

All of the installations employ alternating currents, using transformers to raise the voltage at the transmission end of the line and to reduce it again at the receiving end, but Professor Ayrton is not altogether sure that the alternating current is the best for this purpose. That there are advantages in the alternating current dynamo for the generation of the electrical energy must be conceded, but with improvements in continuous-current dynamos there is no reason why high voltages may not be employed for currents of either kind, and from the point of view of economic transmission 60,000 volts alternating means exactly the same as 60,000 volts direct. Indeed, from the point of view of the maintenance of insulation, the advantages are in favor of the continuous current. This is especially the case if we consider that with the alternating current there is a possibility that resonance effects may produce pressures far above the normal working voltages.

"Much damage has been done to electric cables, used for the distribution of power, by these unexpected high pressures produced by resonance in alternate current circuits. A cable may have been tested at twice or thrice the working pressure and passed as satisfactory. But if there is a liability of a pressure being applied, which, as you see, may in somewhat extreme cases be twenty or thirty times the working pressure, what avails it that there is a factor of safety of 2 or 3?—disaster must follow.

"Now with direct current for long distance transmission there is no question about the electric pressure at the top and bottom of a wave being much greater than the mean pressure, no question about self-induction reducing the current—no objection, therefore, to putting the conductors as far apart as the risk of brush discharge may necessitate—no question about capacity current, no resonance troubles, etc.

"I wonder whether any of you are thinking—Well, perhaps there may be something in this heresy after all. No? Oh! then you are thinking, if the arguments were sound, the direct current system would have been already employed for long distance transmission? Well, but it has! Power up to 3,000 horse has been transmitted with direct current, at 14,000 volts, from Combe Garot to Le Locle and La Chaux de Fonds, round a circuit 32 miles long; 4,600 horse power has been transmitted with direct current, at 23,000 volts, 35 miles from St. Maurice to Lausanne; and a transmission system for 6,000 horse power, at 60,000 volts, over 114 miles from Moutiers to Lyons, is in course of construction.

"Another advantage that is possessed by all these examples of direct current transmission carried out by M. Thury is that it is the current that is kept constant and the electric pressure that is automatically raised when the demand for power is increased, whereas with the ordinary alternate current system it is the pressure at the lamp end that they aim at keeping constant, and the current that varies automatically with the demand for power.

"Now it is far more easy to maintain the constancy of the current flowing round a long circuit than to prevent the bobbing up and down of the electric pressure at the

distant end of a long transmission line, and that irritating dancing of the lights, with which Johannesburg is so familiar, would be particularly difficult to avoid if the transmission line were long and the electric pressures at its two ends differed by some thousands of volts.

"Constant current has also its well known disadvantages, but these would not come into play if the constant current were not taken into houses, mines, etc., but used to drive motor generators in substations, the dynamo portion of the motor generator being of any type desired."

Taking into account the success which has been obtained with the electrical long-distance transmission of power in America the question naturally arises: Is such an industrial revolution in store for South Africa? At first sight such a transformation does not seem practicable, since South Africa has ample coal fields, and long-distance electric distribution does not appear to have much chance. It must be remembered, however, that in South Wales, and in the Tyne district, coal mining companies have found it to their advantage to take power from supply companies rather than to generate it for themselves, because the two industries of coal mining and power generation are distinct, and can be operated to better advantage separately than together. We know what has been done and what is under completion at Niagara, but at Niagara there is a large demand for power within reasonable distance, that there is small doubt that before long the hydraulic power there utilized will be five times as great as the total amount passing over the Victoria Falls in August, but no such demand exists in South Africa, and there is no prospect of its existence anywhere near the falls. Such a possibility may develop later in South Africa, but this does not appear at the present time, nor in the near future.

THE VIBRATIONS OF STEAMSHIPS.

APPARATUS FOR DETERMINING THE NATURE AND CAUSES OF VIBRATIONS AND THE PRACTICAL METHODS OF MINIMISING VIBRATORY ACTION.

Otto Schlick—Verein Deutscher Ingenieure.

WITH the increase in powering and speed of steamships there has appeared the necessity for considering the vibratory actions which result from the movements of reciprocating parts of the engines, the behaviour of the screw propellers, and the periodicity of the hulls of large vessels. Numerous attempts have been made to prevent or minimise such vibrations, and from the early experiments of Bourne and of Ericsson, nearly fifty years ago, down to the present, the problem has been studied and attacked in practice. Among those who have contributed largely toward the solution of this problem the name of Herr Otto Schlick is well known, and his work in connection with the *Bureau Veritas,* and with the machinery of the more recent steamers of the Hamburg-American line, has attracted interested attention in Europe and America. Since 1884, when he presented a paper upon the subject before the Institution of Naval Architects, he has been engaged in practical work in this line, and in a paper in a recent issue of the *Zeitschrift des Vereines Deutscher Ingenieure* he examines the present state of the question, discussing especially the practical use of the pallograph, an instrument for recording and analysing the vibratory actions in steamers in actual service.

Herr Schlick refers to the behaviour of certain transatlantic steamers, notably the Normannia and the Fürst Bismarck, of the Hamburg-American line, and also mentions the experimental investigations made upon the Campania and Lucania, of the Cunard line. These latter experiments showed that the actual amplitude of the vibrations was much smaller than had been thought, and confirmed the fact that under ordinary conditions it is impossible to determine the nature and extent of such vibrations, owing to the absence of any stationary base for observation. It was soon found, however, that excessive vibration occurred when the period of the engines coincided with a vibration period of the hull, and in the case of the vessels just mentioned the vibrations

were materially diminished by altering the pitch of the propellers in order to permit the number of revolutions of the engines to be changed to a speed out of harmony with the period of the hull, and this method has been used in the case of later vessels.

So far as the engines themselves are concerned, much has been accomplished during the past few years by the introduction of the system of balancing of the reciprocating masses by the corresponding modification of the crank angles, using four-crank engines. This system, the practical introduction of which is largely due to the work of Herr Schlick himself, is now becoming general on all large steamships, and it has done much to minimise the vibratory action of the engines. This method, however, does not entirely eliminate the vertical element, and in all cases the vibrations due to the action of the screw propellers remain to be considered.

Another question to be considered is the action of the two sets of engines in twin-screw propulsion, this being the arrangement which is almost invariably adopted in modern vessels. If it were possible to operate the separate engines driving the twin screws in such a manner that the piston positions would hold an invariable relation, the problem would be simplified, but in practice this is not possible, and the result is that the relations of the unbalanced elements of the two sets of engines do not hold a constant relation as regards the hull.

In order to minimise the action of the unbalanced action of the two sets of engines Herr Schlick assumes that each set of engines must be first balanced as fully as possible by the use of the four-crank system, the crank angles being determined so as to equalize the action of the inertia of the reciprocating parts as fully as possible. It then remains to so adjust the speed of rotation that the period of the hull and the disturbing influence of the propellers shall become a minimum, and this is a matter which demands the use of special investigating apparatus, after the vessel has been completed.

In order to investigate the nature and magnitude of the vibratory actions existing in a vessel, Herr Schlick has devised the apparatus which he has called the pallograph, this being a device in which the vertical and horizontal vibrations are separated and recorded upon a strip of paper moved by clockwork. The pallograph consists of four parts, the device for showing the vertical movement, the device for indicating the horizontal movement, the clockwork for moving the paper and marking the time intervals upon the record, and the electro-magnetic attachment for marking the crank positions on the paper. The vertical and horizontal movements are recorded by the use of levers carrying weights, the inertia of which opposes the motions of the hull, these being so suspended as to be capable of movement in the vertical and horizontal planes only, the action of the weights being opposed by helical springs. The fulcrums upon which the levers are suspended are adjustable so that the period of vibration of the apparatus may be made to coincide with the number of vibrations of the hull per minute, or with some exact multiple of it, and when so adjusted the device responds very vigorously to the vibrations of the vessel.

Since it is impracticable to insure the uniform feeding of the recording paper strip under all the conditions on shipboard, the apparatus is provided with a lever which marks every second on the paper, while another lever, operated by electro-magnetic contact with the engine shaft, records the position of the cranks, all the data for an investigation of the conditions of vibration being thus recorded.

In analysing the diagrams produced by the pallograph Herr Schlick recommends that the curves be enlarged photographically to about ten times their original dimensions, this enabling complex curves to be studied by the harmonic analysis and separated into their simple components. The analysis preferred by Herr Schlick is the graphical method of Dr. Fischer-Hinnen, of which he gives a detailed example.

By following the methods of adjusting the crank angles to equalize the action of the reciprocating masses, the vibrations due to a single engine of the four-crank type may be reduced to a minimum, but in the modern twin-screw steamship there are other causes of vibration which, if permitted to act in harmony with the period of

the hull, may give rise to unpleasant effects. Thus it is practically impossible to maintain both sets of engines at the same speed and in the same phase relation, and while their unbalanced efforts may, in one phase oppose each other, the gradual shifting of this relation occurs until the effects reinforce, instead of neutralising each other, and thus marked periods of disturbances may occur.

Again, it is impracticable to construct all the blades of a screw propeller so exactly alike as to insure freedom from vibration in the water, and indeed it is not known to what extent the deflection and deformation of the blades under the heavy stresses to which they are subjected may alter their action.

Since the limitations of harbors and docks control to a large degree the proportions of the hulls of modern vessels, it is impossible to use entire freedom in design to meet the stresses. The depth of hull is limited by the maximum draught of the harbor entrances of the great seaports, so that increase in displacement must be mainly obtained by increased length and beam, and hence it is impracticable to construct ships with as great resistance to vertical as to horizontal stress. By the use of the pallograph the action of the forces upon the hull in relation to the propelling machinery at any moment may be determined, and an intelligent use of this important piece of apparatus should lead to continual progress in methods for overcoming the injurious and unpleasant vibrations so frequently observed.

ELECTRICITY AND POWER ENGINEERING.

THE INFLUENCE OF ELECTRICAL GENERATING AND TRANSMISSION APPLIANCES UPON THE DEVELOPMENT OF PRIME MOVERS.

W. B. Esson—Civil and Mechanical Engineers' Society.

THERE has been much written about the transformation of mechanical power into electrical energy, but the opposite side of the question, the influence which the development of electricity has had upon power machinery, has not been so fully considered. In the course of his presidential address before the Civil and Mechanical Engineers' Society, Mr. W. B. Esson referred to some interesting features in connection with this phase of the subject, and we give some of the salient points made by him.

After referring to the development of the dynamo, and to the impetus given to long distance transmission by the introduction of the transformer and the extension of high-voltage alternating currents, Mr. Esson showed the influence which these things have had upon power-generation and distribution. Thus, the ability to transmit power electrically has had a marked effect upon the use of water power, and from being a rather antiquated and limited sort of method the use of falling water as a source of energy has become enormously extended.

Referring to this feature, Mr. Esson says that it is not easy to estimate the total of the water power which has been utilised all over the world as a consequence of the erection of hydro-electric stations.

"I believe I am well within the mark in placing the total capacity of the hydro-electric power-houses at work and under construction on the American continent alone at a million horse-power. In Italy, Lombardy alone accounts for 88,000 horse power in hydro-electric power-houses at work and under construction, while Switzerland, the home of hydro-electrics, accounts for 220,000 horse power. Taking the whole world, the water power utilised in the hydro-electric stations must lie somewhere between a million and a half and two millions of horse power—a vast force the greater part of which might have run to waste for all time had it not been for the invention of the dynamo.

"All these schemes cannot be placed in the same category. Cases are numerous in which electricity is employed merely as a means whereby the power of water can be conveniently parcelled out to various industrial undertakings in the immediate neighbourhood. Such cases furnish an example of power distribution rather than of power transmission. The work is brought to the

power, and the enterprise is of a kind differing entirely from those in which the power must be transmitted over a considerable distance, and in which by no possibility could the work ever be brought to its source. As furnishing a case of the former kind Niagara may be cited. The supply of cheap electrically distributed power has been the means of founding a most important industrial district and of increasing land values to a large extent. There is no doubt that here, though distance does not come in so much, electricity furnishes by far the best means of power distribution, but several other means have been proposed, and an altogether different problem is that of transmitting power to a distant region practically inaccessible so far as fuel is concerned on account of the enormous cost of transit. The works in the immediate neighbourhood of Niagara use about 60,000 horse power, and their demand continues all the year round without ceasing, the greater portion of the power being used for metallurgical and electro-chemical processes in the form in which it is received. The Niagara industries present the case of Mahomet going to the mountain, but amongst the cases of the mountain taking itself to Mahomet the transmission to the Kolar goldfield at Mysore already referred to furnishes a very good example. For years prior to 1899 the project of utilising the falls was discussed, but as often was it abandoned because of there being no local market for the power and no prospect of any industries being tempted to the district. But the falls were there with their huge power running to waste, and the Kolar goldfield was but 92 miles distant. Fuel in the mines was excessively dear, while the possibility of transmitting the power economically to great distances had been demonstrated in the case of other undertakings. The problem of utilising the power was in 1900 again taken up with all the knowledge which had been gained elsewhere brought to bear on it, and an enterprise is in full swing to-day by which 4,000 horse power is delivered to 10 mining companies in the Kolar fields, the revenues from which are sufficient to recoup the Mysore Government for the whole of its capital outlay in six years."

Naturally this growth in the use of hydraulic power has caused corresponding attention to be given to all departments of hydraulic engineering, and the subjects of water supply, of flow in channels, of penstock and pipe-line construction, and of all the details of heavy water-power plant have attracted renewed study and effort.

"Needless to say, turbine construction has been influenced to a very large extent by electric power development. Apart from the enormous amount of hydraulic engineering work represented by the utilisation of something between one and a half and two million horse power, the improvement in the efficiency of the turbine from the date of the Francis wheel must be credited directly to the great stimulus electric power work gave to turbine manufacture. While in 1870 the average power of each wheel made by one of the leading turbine firms was 70 horse power, in 1903 it was over 700 horse power, and the annual output in horse power had increased from 10,000 to 130,000. Twenty-five years ago the construction of a turbine giving 500 horse power was something of an achievement, to-day turbines are at work of 10,000 horse power. In all modern installations the electric generators are coupled direct to the turbine shafts. When it is possible, a horizontal shaft arrangement is chosen, though it is noteworthy that up to the present, owing to the special conditions to be met, the largest turbines have had vertical shafts. Generally the full-load turbine efficiency is about 80 per cent., though higher figures have been obtained, but the power of the wheel, the speed, and the fall all influence the useful return."

The relation of electrical development to the steam engine has been a rather curious one, and Mr. Esson discusses certain portions of the subject only. When the continuous-current dynamo was first made a practical machine it demanded high rotative speeds and close governing, and the result was an impetus to the manufacture of the short-stroke high-speed engine, especially of the single-valve automatic variety with shaft governor. The higher efficiency of the larger slow-running Corliss engine led to the modification of the dynamo to adapt it to this form of engine, and the development of the large alternator

permitted the very effective combination of the generating set in which the rotor of the dynamo is incorporated with the flywheel of the engine.

Now, however, a second phase of the development has been entered and the success of the steam turbine is causing the alternator to be redesigned to adapt it to the high rotative speeds of the turbine, and thus the two arts of steam-engine building and dynamo design have reacted, each upon the other.

Another source of power, which is being adapted for the economical generation of electricity, is the gas engine. Since the application of the waste gases of blast furnaces as fuel for large gas engines has been successfully made it is evident that the supply of power gas is vastly greater than is needed for the mere driving of the furnace blowing engines. At the present time there are on the Continent probably not fewer than 100 gas engines averaging more than 500 horse power each in operation driving electric generators and furnishing current for power and lighting purposes about the works.

"On the Continent a number of installations have been erected in which the by-product gas from coke ovens is utilised to drive gas-engines. In the Ruhr coke-making district in Germany there is an aggregate of no less than 6,000 horse power produced by the utilisation of waste gases from the ovens. There are coked in this country annually about 50,000,000 tons of coal, and the gas from the coke ovens is capable of yielding in gas-engines 1,000,000 horse power continuously. In Germany and Sweden there are several works in operation producing power gas from peat. For the production of this gas the peat can contain as much as 45 to 50 per cent. of water, and it is not unlikely that there may be an opening here for the establishment of power stations near peat moors remote from coalfields. I have heard of a peat moor about 1¾ miles square capable of supplying enough gas to generate 10,000 horse power for 60 years. This may or may not be an exaggeration, but it is certain that there is enormous industrial waste in this country, and that true co-operation in the widest sense of the term between different industries would result in large savings."

STEEL FOR MOTOR-CAR CONSTRUCTION

NOTES ON ALLOY STEELS ESPECIALLY ADAPTED FOR USE IN THE CONSTRUCTION OF AUTOMOBILES AND INTERNAL COMBUSTION MOTORS.

Léon Guillet—Iron and Steel Institute.

THE development of new industries frequently reacts upon other lines of work, and often new demands appear which are met by correspondingly new products. It is not peculiar, therefore, that the growth of such an extensive department of work as the automobile industry should create a marked activity in the production of materials of construction of great strength, toughness, and capacity to resist shocks. When it is realized also that results rather than economy in first cost, are included in the demand, we need not be surprised to see the latest resources of the metallurgist drawn upon to supply materials to meet the exacting requirements of the automobile builders. The eminent French metallurgist, M. Léon Guillet, whose investigations upon the various alloy steels have attracted much attention, has devoted himself to this subject among others, and at the recent meeting of the Iron and Steel Institute he presented a paper upon the steels used in motor-car construction in France, which contained many points of interest and value, both to builders of automobiles, and to the engineering profession in general.

M. Guillet states that two groups of the various alloy steels have found applications in the construction of motor cars, these being the ternary steels, containing iron, carbon, and a third substance; and the quaternary steels, or alloys of iron, carbon, and two other substances. Under the first group he discusses the nickel steels, the chrome steels, and the silicon steels, these latter being frequently known as silicon-manganese steels. The quaternary steels actually in use are the chrome-nickel

steels, and certain other alloy steels of which the composition is as yet kept secret. These steels do not include those employed for cutting tools in motor-car shops, the discussion being limited to actual materials of construction, forming portions of the completed vehicles.

In discussing the nickel steels, M. Guillet refers to a very common error, that of considering only the percentage of nickel, regardless of the carbon content. The mechanical properties of these alloys depend upon the relative carbon and nickel content, and to mention one without giving the other is meaningless. To speak of a 2 per cent. nickel steel without stating the percentage of carbon is to convey no real information whatever, and both proportions should always be given. In actual practice there are five nickel steels of practical value, as follows: Steels with low nickel (1 to 6 per cent.) and very low carbon (0.10 to 0.25 per cent.); Steels with low nickel (1 to 6 per cent.) and medium carbon (0.25 to 0.40 per cent.); Steels with medium nickel (10 to 18 per cent.) and with medium carbon (0.25 to 0.40 per cent.); High nickel steels (30 to 36 per cent.) with low carbon (0.12 to 0.20 per cent.); and High nickel steels (20 to 30 per cent.) and high carbon (0.60 to 0.80 per cent.).

The steels containing low nickel and low carbon are used in place of ordinary case hardened steel. The difficulties which are encountered with ordinary carbon steels in obtaining a hard exterior with a non-brittle interior are well known, but by the employment of the proper nickel steel these troubles may be wholly avoided. By taking a steel with 0.12 per cent. of carbon and 7 per cent. of nickel, and subjecting it to a cementation operation, so that the exterior contains from 0.90 to 1.0 per cent. of carbon, similar to ordinary case hardening, but without subsequent quenching, but on the contrary followed by a very careful slow cooling, an entirely satisfactory surface hardening is obtained. This process avoids all troubles from cracking or warping, and gives a hard exterior with a tough interior. This process, carried on under license of the De Dion Bouton Company, is extensively used for axles, crank shafts, and gears. Other low nickel steels, containing medium carbon, are used for journals and for axles, because of their strength and toughness.

The steel containing a high percentage of nickel and low carbon is chiefly known to engineers by the 36 per cent. alloy of Guillaume, this being the alloy of minimum expansion, used for tapes and wires for geodetic measurements because of its constancy in length under wide temperature changes. In the motor-car industry, however, steels containing low carbon and at least 32 per cent. of nickel are found to possess a very high degree of resistance to shock, and hence are especially adapted for valves. The fact that these alloys are untarnishable is also a valuable property in this connection.

Formerly the steels containing high nickel and high carbons were much used for crank shafts, valves, and other parts of automobiles, but M. Guillet points out serious disadvantages which they possess. Thus, in the course of the mechanical and thermal treatment necessary in working, they are apt to undergo transformations which materially reduce their resistance to shock, and as these changes cannot be determined during the course of the work the strength of the finished product remains uncertain. The high cost of such alloys also renders them undesirable, and they are being abandoned.

In regard to other ternary steels, M. Guillet mentions chrome steel, containing 1 to 1.2 per cent. of carbon and 1 to 2.5 per cent. of chromium, this being used for bearings. In order to avoid cracking, this alloy should be given a double quenching, first at 800° C. in oil, and then at 850° C. in water.

The silicon steel used for automobiles contains from 0.30 to 0.70 carbon and 2.5 to 0.80 per cent. silicon, the proportions of carbon and silicon varying inversely. It may also contain from 0.35 to 0.70 per cent. of manganese. Silicon steel is used for springs, and sometimes for gears.

Vanadium steel has not yet been used in automobile construction to any extent, but according to M. Guillet, it appears to be full of promise.

Of the quaternary steels, the chromium-nickel alloys are the principal ones having practical applications. Thus, a steel con-

taining 0.25 to 0.45 carbon, 2.5 to 2.75 nickel, and chromium 0.275 to 0.60 per cent., gives, after quenching at 850° C. and reheating to 350° C., a certain degree of hardness, unaccompanied by brittleness, but with a very high elastic limit, so that it may be used without case hardening. Another combination, containing 0.25 to 0.45 carbon, 5 to 6 per cent. of nickel, and 0.5 to 1 per cent. chromium, is especially strong and tough after annealing at 850° C., and cooling in air, and is especially used for shafts and journals.

The medium and high nickel quaternary steels have not been found of much value in practice and are now little used.

M. Guillet mentions another quaternary steel, known to the trade as NY steel, the actual composition being kept secret. This is made by the Commentry-Fourchambault Company at their works at Imphy, and it appears to possess many valuable properties. Thus, before hardening it possesses all the qualities of a semi-hard steel, while after quenching at 850° C., without reheating it possesses the properties of quenched and reheated silicon steels.

Summing up, the special steels actually used in France in motor-car work are as follows:

Steels with low percentages of carbon and nickel (pearlitic steels) which are used for parts which require cementing and quenching, such as shafts, direct gears, etc.;

Steels with medium percentages of carbon and low percentages of nickel, used after quenching and reheating, for a large number of parts, shafts, gearing, pinions, etc.;

Steels low in carbon and with high percentages of nickel, used for valves;

Chromium steels, with high carbon and low chromium percentages, used for bearings;

Silicon steels, used for springs and for gearing;

Nickel-chromium steels, with low percentages of nickel and chromium, employed for numerous parts requiring resistance to shock and a certain degree of hardness.

To these may be added the new steel above mentioned, the composition of which has not yet been made public.

POWER-STATION DESIGN.

NOTES ON USEFUL DETAILS IN CONNECTION WITH THE DESIGN AND OPERATION OF POWER GENERATING STATIONS.

F. N. Bushnell—American Street Railway Association.

WHEN, at the present time, a power station is mentioned, the inference almost always follows that an electrical generating station is meant, and this conclusion will generally be found to be correct.

At the same time it must not be forgotten that electricity is not a source of power, but only a convenient means for transmitting the power generated from some other source to the point where it is to be converted into mechanical energy. In the paper by Mr. F. N. Bushnell, presented before the American Street Railway Association, the source of power is taken as steam, and when we consider that more than 90 per cent. of the power of the engines is electrically transmitted and delivered, it is evident that we must look for any gain in efficiency to other than the electrical departments.

There are other questions, however, besides economy in fuel which demand attention, one of these being the limitation of interruption to but a portion of the plant, and in this connection Mr. Bushnell describes the methods in use to prevent interruption to service.

"The practice of different engineers has gradually worked toward a type of station which is now so generally adopted for street railway work where limitations are not placed upon the design by the size or shape of the available site, that it can fairly be said to represent standard practice in modern power station engineering. In stations of very large size the boilers are frequently arranged in two tiers, or in groups, each group having its own chimney, and flues and independent systems of feed and steam piping. This arrangement is now generally referred to as the unit system, the distin-

guishing feature of which is that the boilers, engines and generating apparatus are arranged in separate units or groups, each of which embodies all of the essential features of a complete generating plant, and the great advantage of which lies in the fact that trouble with any single piece of apparatus is localized, so that its effect is felt only in that unit of which it forms a part. Provision for carrying the load in the event of a breakdown of any important part of the apparatus is made by installing an additional or spare unit.

"While the unit system is now almost universally employed in the larger power stations, it is usually somewhat modified for smaller plants where the liability to interruption of the service is not so great or the results so disastrous, the chief difference being in the arrangement of the steam and feed piping. The steam piping from the boilers is run to a longitudinal header, from which the connections to the engines are taken off at convenient points. This steam header is divided into sections by means of gate valves, which permit of any section being cut out at the convenience of the operator for the purpose of making repairs. Usually two systems of feed piping are provided, one of which supplies hot water to the boilers through the heaters and economizers, while the second, or auxiliary system, supplies cold water, or water direct from the heaters, in case of trouble with the main system. This arrangement of piping provides sufficiently against interruption in small and medium-sized plants, and in a system carefully laid out with due consideration for the troubles which are likely to arise, it is hardly probable that the disarrangement of any one part will cause serious interruption of the service."

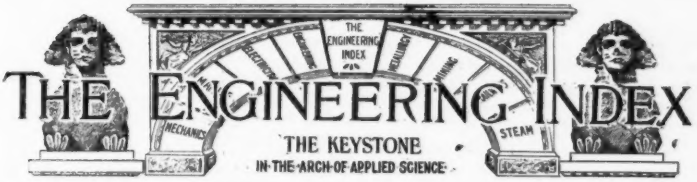
In considering the arrangement of a power station, the question of system includes the proportion of the units to the work which is to be done, and this point is especially emphasised by Mr. Bushnell.

"The number and size of units to be installed is one of the most important problems bearing upon fuel economy which the engineer is called upon to solve. In order to obtain the maximum efficiency from the prime movers and their auxiliaries, it is necessary that they should be proportioned to the load they are intended to drive, so that if possible they may be operated at all times at or near their rated capacity.

'In electric railway power stations it is not regarded as practicable to change the speed of the air or circulating pumps, or to alter the quantity of cooling water, to suit the varying loads upon the station, and these auxiliaries are usually operated at a point sufficient to take care of the maximum load. The power required to drive them is therefore practically constant, and their steam consumption per unit of output will vary indirectly as the load on the main engines. Under ordinary operating conditions, where the exhaust steam is used for heating the feed water, only about 12 per cent. of the heat in the total steam generated can be used for this purpose, and all steam used by the auxiliaries in excess of this must go to waste; and it follows that in addition to the losses due to the reduced efficiency of the prime movers at light loads, the percentage of loss in the auxiliaries will increase very rapidly as the load upon the main engine decreases, and the best economy of the entire plant will be obtained only when the engines are operated at or slightly above their rated capacity."

Passing from the engine to the boiler room, it appears that the opportunity for improvement here lies with the furnace rather than with the boiler itself, since boiler efficiencies have already reached 75 to 80 per cent., giving little room for improvement. Here, probably, the best opportunities for economy are to be found in the prevention of leakages of cold air, in the proper mixture of air and fuel, and in the reduction of heat losses. By keeping accurate records of fuel consumption, flue gas, gas temperatures and composition, and rates of combustion the opportunities for economies in the combustion of the fuel should be detected and applied.

Mr. Bushnell is inclined to consider mechanical stokers as conducive to fuel economy, but above all he emphasises the importance of keeping regular records of coal and water consumption and of all the conditions surrounding the combustion of fuel.



The following pages form a **descriptive** index to the important articles of permanent value published currently in about two hundred of the leading engineering journals of the world—in English, French, German, Dutch, Italian, and Spanish, together with the published transactions of important engineering societies in the principal countries. It will be observed that each index note gives the following essential information about every publication:

(1) The title of each article,
(2) The name of its author,
(3) A descriptive abstract,
(4) Its length in words,
(5) Where published,
(6) When published,

(7) *We supply the articles themselves, if desired.*

The Index is conveniently classified into the larger divisions of engineering science, to the end that the busy engineer, superintendent or works manager may quickly turn to what concerns himself and his special branches of work. By this means it is possible within a few minutes' time each month to learn promptly of every important article, published anywhere in the world, upon the subjects claiming one's special interest.

The full text of every article referred to in the Index, together with all illustrations, can usually be supplied by us. See the "Explanatory Note" at the end, where also the full titles of the principal journals indexed are given.

DIVISIONS OF THE ENGINEERING INDEX.

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CIVIL ENGINEERING

BRIDGES.

Arches.

A Reinforced Concrete Bridge, Sorsogon, P. I. H. L. Stevens. Illustration and brief description of an arch bridge of 45-ft. span and 6-ft. rise. 600 w. Eng Rec—Oct. 21, 1905. No. 72804.

The Bridge over the Syra Valley at Plauen in Voigtland (Die Syratalbrücke in Plauen im Vogtlande). M. Foerster. A well illustrated description of the construction of this, the widest span masonry arch in the world, being 90 metres clear span. 2500 w. Schweiz Bauzeitung—Oct. 14, 1905. No. 72747 B.

The Proportions of Reinforced Concrete Arches (Dimensionierung der Betoneisernen Gewölbe). Dr. Max R. v. Thullie. Giving formulas and tables for practical use, together with a plate of curves for the graphical determination of the coefficients. 3500 w. 1 plate. Oesterr Wochenschr f d Oeffent Baudienst—Sept. 23, 1905. No. 72749 D.

We supply copies of these articles. See page 477.

Cantilever.

Cantilever Bridge of 1,800-Ft. Span Across the St. Lawrence. Illustrated detailed description of the bridge under construction near Quebec. 1200 w. Engng—Sept. 22, 1905. No. 72314 A.

Croton.

The New Croton Dam Bridge. Illustrates and describes the steel arch span across the spillway of the Croton reservoir. 2200 w. Eng Rec—Oct. 21, 1905. No. 72809.

Erection.

Assisted Cantilever Method. An illustrated explanation of this method as applied to the erection of permanent steel bridge work for the Western Maryland Railroad, Cumberland extension. 2000 w. Stevens Ind—July, 1905. No. 72828 D.

Havel.

The Iron Railway Bridge over the Havel at Brandenburg (Die Eisenbahnbrücke über die Havel bei Brandenburg). Karl Bernhard. With details of construction and erection of a semiparabolic truss of 90 metres span, with a peculiar form of bracing. 3000 w. Zeitschr d Ver Deutscher Ing—Oct. 14, 1905. No. 72731 D.

Housatonic.

A Through-Truss Short-Span Double-Track Bridge. Illustrated description of a bridge over the Housatonic River, south of Shelton, Conn., typical of the standard construction for that class on the N. Y., N. H., & H. R. R. 1800 w. Eng Rec—Oct. 21, 1905. No. 72808.

New York.

New York Bridges. Montgomery Schuyler. A critical review of the bridges across the East River and the Harlem River, noting their good and bad features. 2200 w. Arch Rec—Oct., 1905. No. 72390 C.

Plate Girders.

Some Deck Plate Girder Bridges on the New York, New Haven & Hartford R. R. Illustrations and information concerning these structures. 1600 w. Eng Rec—Sept. 30, 1905. No. 72366.

Some Through Plate-Girder Bridges, New York, New Haven & Hartford R. R. Gives brief illustrated descriptions of various types. 2000 w. Eng Rec—Oct. 7, 1905. No. 72486.

Variations in Standard Plans for Railroad Plate Girders. Frank W. Skinner. Gives a summary of the conditions relating to web stiffeners on different railroads. 2000 w. Eng Rec—Oct. 7, 1905. No. 72484.

Reconstruction.

Recent Bridge Work on the Nickel Plate. Albert J. Himes. An illustrated account of reconstruction work, replacing the early bridges which were unsuited to the present heavy traffic. 1800 w. R R Gaz—Vol. XXXIX., No. 15. No. 72509.

Steel Bridges.

Steel Railroad Bridges. A summary of replies to circular letters sent out by the Committee on Steel Bridges of the Association of Railway Superintendents of Bridges and Buildings. 1800 w. Eng Rec—Oct. 21, 1905. No. 72806.

Susquehanna.

The Havre de Grace Bridge of the Pennsylvania Railroad. Illustrated detailed description of an interesting bridge across the Susquehanna River, now under construction. It has a total length of 4,154 ft., with one drawspan of 280-ft. 1700 w. Ry Age—Oct. 6, 1905. No. 72422.

Transporter.

The Ferry Bridge Across the Ship Canal at Duluth, Minnesota. C. A. P. Turner. An account of the circumstances and conditions that influenced the selection of this type, with illustrated description of the structure, its construction, and operation. 5500 w. Pro Am Soc of Civ Engrs—Oct., 1905. No. 72831 E.

Viaduct.

The Concrete Railway Viaduct at Cannington. Gives data, concerning a viaduct built wholly of concrete, taken from a paper presented to the Inst. of Civ. Engrs. by Arthur Wood-Hill and Edward D. Pain. Ills. 2700 w. Eng Rec—Oct. 21, 1905. No. 72811.

CONSTRUCTION.

Building Details.

Structural Details of the General Electric Company's Power House, Schenectady. Illustrated description. 1800 w. Eng Rec—Sept. 30, 1905. Serial. 1st part. No. 72361.

Foundations.

Coaling Tower Foundations of the Union Electric Light & Power Co., St. Louis. An illustrated detailed description of difficult foundation work, owing principally to the nature of the ground and depth of water encountered. 2000 w. Eng Rec—Oct. 21, 1905. No. 72803.

Galleries.

Gallery Construction, Christ Church Memorial Building, New York. Illustrates details of the steel work, describing the construction. 700 w. Eng Rec—Oct. 21, 1905. No. 72810.

Gas-Holder.

Construction Details of a Modern Gas-Holder. Gives illustrated detailed description of the construction of one of six

gas-holders recently built in New York City, and fairly typical of the best American practice. 2500 w. Eng News—Oct. 26, 1905. No. 72812.

Reinforced Concrete.

A Lighthouse of Reinforced Concrete. Translated from *La Nature*. Illustrated description of a lighthouse constructed by the Russian government at the entrance to the canal that connects the port of Nicolaief with the Black Sea. 1100 w. Sci Am Sup—Oct. 14, 1905. No. 72504.

Failure of the Roof of a Reservoir at Madrid (Effondrement de la Couverture d'un Reservoir d'Eau en Construction à Madrid). With illustrations showing the manner of failure of the reinforced concrete vaulting. 1800 w. Génie Civil—Sept. 23, 1905. No. 72709 D.

Reinforced Concrete as a Fire-Resistant. Reviews the rules of the Fire Offices Committee in London, and discusses their importance. 2400 w. Engng—Oct. 6, 1905. No. 72545 A.

Reinforced Concrete Construction. Lewis A. Hicks. Read at the Pac. Coast Eng. Cong., Portland. An examination of available data pertaining to the design of reinforced concrete cage construction. 9000 w. Jour of Elec—Oct., 1905. No. 72577 C.

Reinforced Concrete Shops and Car Houses, Central Pennsylvania Traction Co., Harrisburg. Mason D. Pratt. Illustrates and describes new buildings, built entirely of reinforced concrete, and covering an area of 53,000 sq. ft. 1400 w. Eng Rec—Sept. 30, 1905. No. 72363.

See also Civil Engineering, Bridges.

Tunnels.

Completion of Twin Tunnels Under the Hudson River. Illustrations and account of the completion of these tunnels connecting Jersey City with New York. 1100 w. Sci Am Sup—Oct. 14, 1905. No. 72505.

MATERIALS OF CONSTRUCTION.

Cement.

Methods of Testing and Some Peculiarities of Cement. W. A. Aiken. Read before the Assn. of Am. Portland Cement Mfrs. Outlines the methods of testing carried out by the Department of Inspection of Materials under the Board of Rapid Transit R. R. Commissioners of the City of New York. 3400 w. Cement Age—Oct., 1905. No. 72652.

Cement Plant.

The Works of the Kosmos Portland Cement Co. Illustrates and describes a plant in Kentucky and its equipment. 1800 w. Eng Rec—Oct. 21, 1905. No. 72807.

Concrete Blocks.

The Manufacture of Concrete Blocks and Their Use in Building Construction. H. H. Rice. (Prize paper.) Considers the materials, mixing, and manufacture of concrete blocks, the curing, facing, testing and cost, with suggestions for their use in construction. 7500 w. Eng News—Oct. 5, 1905. No. 72399.

The Manufacture of Concrete Blocks and Their Use in Building Construction. William M. Torrance. (Second prize paper.) Discusses the proper ingredients, forms of blocks, cost, engineering and architectural considerations, &c. Ills. 10000 w. Eng News—Oct. 12, 1905. No. 72496.

The Manufacture of Concrete Blocks and Their Use in Building Construction. Extracts from papers submitted to the *Engineering News* competition and not receiving prizes. Ills. 6000 w. Eng News—Oct. 26, 1905. No. 72814.

The Philadelphia Specifications for Concrete Building Blocks. Gives the regulations in force in the Borough of Manhattan, New York, and the rules and regulations covering the manufacture and use of concrete building blocks in the city of Philadelphia. 4200 w. Cement Age—Sept., 1905. No. 72409.

Fireproof Wood.

Results of Tests of Fireproof Wood at the Insurance Engineering Experiment Station. Report of Prof. Charles L. Norton, of tests made of specimens. 3500 w. Eng News—Oct. 5, 1905. No. 72404.

Lime.

The Analysis of Raw and Spent Lime. H. Leicester Greville. Describes the method devised by the writer for the analysis of spent lime, and the methods in use for the determination of free lime. 2200 w. Jour of Gas Lgt—Oct. 17, 1905. No. 72695 A.

Paving Materials.

The Importance of Preliminary Tests of Paving Materials. J. W. Howard. Read before the Am. Soc. for Munic. Imp. Urges the importance of making scientific tests of materials used and discusses briefly various kinds of pavement. 1500 w. Eng Rec—Oct. 7, 1905. No. 72488.

MEASUREMENT.

Surveying.

The Survey of the Kaiser Franz Josef I. Tunnel at Breth-Raibl (Die Achsabstechung des Kaiser Franz Josef I. Hilfsstollens in Breth-Raibl). Alois Plasser. With plan of the triangulation system used in connection with the running of a tunnel of 4,800 metres long in

the Raibl lead and zinc mines. 2000 w. Oesterr Zeitschr f Berg u Hüttenwesen—Oct. 7, 1905. No. 72741 D.

MUNICIPAL.

Dust Prevention.

The Use of Oil on Macadam Pavements. Theodore F. White. Read before the Soc. of Munic. Imp. Gives the experience on California roads, and the satisfactory results obtained by asphalted macadam roads. 2000 w. Munic Engng—Oct., 1905. No. 72620 C.

London Traffic.

The Engineering of London Traffic. Editorial review of a recent report of the Royal Commission on London traffic by the advisory board of engineers. 3200 w. Engng—Oct. 13, 1905. No. 72687 A.

Manila, P. I.

Municipal Improvements in Progress and Projected at Manila, P. I. J. F. Case. Information concerning the scheme of improvements comprising the expenditure of about $6,000,000 within the next four years. Includes a sewer system, gravity water supply, bridges, &c. Explains the conditions to be met. 1500 w. Eng News—Oct. 19, 1905. No. 72587.

Mosquitoes.

A Review of the Anti-Mosquito Campaign. Edward S. Rankin. Read before the Am. Soc. of Munic. Imp. Principally an account of the work in New Jersey. 2000 w. Munic Engng—Oct., 1905. No. 72616 C.

Pavements.

Asphalt Paving. Andrew Rosewater. Condensed paper read before the Toledo convention of the League of Am. Munic. Discusses the construction, maintenance and cost. 3500 w. Munic Jour & Engr—Oct., 1905. No. 72324 C.

Effect of Water Upon Asphalts. A. W. Dow. A criticism of statements in a paper by Mr. Andrew Rosewater. 2500 w. Munic Engng—Oct., 1905. No. 72622 C.

Public Lighting.

Electricity v. Gas for Public Lighting. An explanation of the substitution in London and other English cities of gas for electric lights, and some information in regard to the comparative cost. 3500 w. Elec Rev, Lond—Oct. 6, 1905. No. 72539 A.

Refuse.

Disposition of Municipal Refuse. W. F. Morse. Read before the Am. Pub. Health Assn., at Boston. Describes American conditions, giving data from representative cities. 3200 w. Munic Jour & Engr—Oct., 1905. No. 72329 C.

The Incineration of Municipal Waste. Howard G. Bayles. Read before Am. Soc. of Munic. Imp. Gives information, gathered from various cities of the United States, as to efficiency, cost, and various features of the practice. 4000 w. Munic Engng—Oct., 1905. No. 72618 C.

Sanitation.

Sanitary Engineering in the Southern States. J. N. Hazlehurst. Read before the Am. Soc. of Munic. Imp. A brief general review of the work accomplished and an outline of the works being installed at New Orleans. 2200 w. Munic Engng—Oct., 1905. No. 72617 C.

Sewage Disposal.

Sewage Contact Beds Declared Superseded by Percolating or Sprinkling Filters. Prof. Bostock Hill. From a paper read before the British Assn. of Mgrs. of Sewage Disposal Works. Briefly discusses some important points in sewage disposal. 600 w. Eng News—Oct. 19, 1905. No. 72588.

Septic Tanks and Double Contact Beds at Burnley, England. Describes the sewage works of a cotton weaving town of about 100,000 inhabitants. They include large detritus tanks, septic tanks and double contact beds. 1700 w. Eng News—Oct. 26, 1905. No. 72813.

WATER SUPPLY.

Filtration.

The Mechanical Filters at Youngstown. Illustrated detailed description of a plant with a normal capacity of 10,000,000 gal. per 24 hours, built to treat the water of the Mahoning River. 3500 w. Eng Rec—Oct. 7, 1905. No. 72487.

Ground Water.

The Diminished Yield of Underground Waters in Southern California. Information from a report of W. C. Mendenhall, at the irrigation congress, showing a decline, and that it is time to stop increasing, indiscriminately, the number of wells. 3000 w. Eng Rec—Oct. 7, 1905. No. 72485.

Hydrants.

Freezing of Fire Hydrants. Gives information concerning the delays caused by frozen hydrants, resulting in great loss of property, considering modern hydrants to be the remedy. 3000 w. Ins Engng—Oct., 1905. No. 72826 C.

Intake.

The New Intake of the Erie Water Works. Describes the extension to the present intake which will draw the supply from Lake Erie instead of from Erie harbor. Ills. 3500 w. Eng Rec—Oct. 14, 1905. No. 72569.

We supply copies of these articles. See page 477.

Irrigation.

Irrigation Engineering. Sir Hanbury Brown. A discussion of the general principles on which the practice of irrigation is based. 3000 w. Engr, Lond—Oct. 20, 1905. Serial. 1st part. No. 72883 A.

The Buford Irrigation Project. General remarks on the extensive irrigation works undertaken by the U. S. Government, with illustrated description of this project in Montana, which contemplates the irrigation of about 60,000 acres of land. 1500 w. Engr, Lond—Sept. 29, 1905. No. 72479 A.

The Salt River Project, U. S. Reclamation Service. Illustrated description of the Roosevelt dam, Salt River, in connection with the irrigation development. 1800 w. Eng Rec—Oct. 14, 1905. No. 72566.

Montreal.

The Montreal Water Works. George Janin. Read before the Am. Soc. of Munic. Imp. Reviews the history of the water supply, and the plans for increasing it. 1800 w. Munic Engng—Oct., 1905. No. 72621 C.

Protection.

The Sanitary Protection of Water Supplies. Kenneth Allen. Considers means of detecting unsanitary conditions and corrective treatment. 9000 w. Jour Fr Inst—Oct., 1905. No. 72607 D.

Pumping.

See Mechanical Engng., Hydraulics.

Purification.

Purification of Water by Copper Sulphate. Daniel D. Jackson. Read before the Am. Soc. Munic. Imp. Gives results obtained by the writer in ponds and reservoirs showing this to be a satisfactory method of removing green growths. 1400 w. Munic Engng—Oct., 1905. No. 72615 C.

Water Purification Works for Toledo. Information concerning the 20,000,000-gal. mechanical filtration plant for the municipal water works in which work is to be started immediately. 1200 w. Eng Rec—Sept. 30, 1905. No. 72362.

Reservoir.

The Baden Reservoir of the St. Louis Water-Works. Illustrations and brief description of an interesting structure. 600 w. Eng Rec—Oct. 21, 1905. No. 72805.

Supplies.

Municipal Water Supplies. Hon. L. H. Chappell. Read before the League of Georgia Munic. Con. Discusses the requirements and methods. 2500 w. Munic Jour & Engr—Oct., 1905. No. 72328 C.

Water Tower.

A Novel Steel Tower and Concrete Platform for a Wood Stave Water Tank. Charles Worthington. Illustrates and describes a structure at Massena, N. Y., having novel features in framing believed to be advantageous and economical. 1200 w. Eng News—Oct. 26, 1905. No. 72815.

WATERWAYS AND HARBORS.

Antwerp.

The Port of Antwerp Extensions. Considers the present accommodations of this port and the enlargements proposed. Ills. 2800 w. Engng—Sept. 22, 1905. No. 72318 A.

Argentina.

Deep-Water Port at San Nicolas de los Arroyos (Puerto de Aguas Hondas en San Nicolas de los Arroyos). Details of proposed improvements of the port of San Nicolas, on the Parana river below Rosario. 3500 w. La Ingenieria—Aug. 30, 1905. No. 72775 D.

Chicago Canal.

Cost of the Chicago Drainage Canal. Gives a summary of receipts and expenditures taken from a recent report. 500 w. Eng News—Oct. 26, 1905. No. 72816.

Cranes.

Modern Slip Cranes (Neuere Helling Krane). Illustrating recent installations of traveling and derrick cranes for use on the slip ways of shipbuilding yards. 1200 w. Schiffbau——Sept. 27, 1905. No. 72768 D.

Sixty-Ton Floating Crane (Schwimmkran von 60 t. Tragfähigkeit). W. Pickersgill. Illustrating a powerful pontoon bridge crane for service in the harbor of Danzig. Details of the framing and machinery are given. 2000 w. Zeitschr d Ver Deutscher Ing—Sept. 30, 1905. No. 72704 D.

Danube.

Towing Tests on the Canal of the Iron Gates (Mitteilungen über die am Eisernen Tor Durchgeführten Schiffszugsversuche). Alois Hoszpotzky. Data and results of dynamometer tests of the power required to tow boats up against the current in the canalized Danube at the Iron Gates. 8000 w. 3 plates. Oesterr Wochenschr f d Oeffent Baudienst—Oct. 14, 1905. No. 72751 D.

Dredges.

Combined Bucket and Suction Dredge. Illustrated description of an interesting dredging vessel built in Holland for service at Monte Video, Uruguay. 1000 w. Naut Gaz—Oct. 19, 1905. No. 72634.

Dredging by Hydraulic Method. G. W. Catt. Briefly describes various types of dredges used for excavating in rivers

and harbors, and gives illustrated description of methods and apparatus used in hydraulic dredging. 3500 w. Iowa Engr —March, 1905. No. 72853 C.

United States Dredge Barnard. Robert S. Riley. Illustrated detailed description of a dredge designed to help open and maintain the new channel for navigation through the delta of the Mississippi River. 4000 w. Marine Engng—Oct., 1905. No. 72337 C.

Graving Dock.

A New Graving Dock at Nagasaki, Japan. Naoji Shiraishi. Dimensions, general information, and illustrated description. 1800 w. Pro Am Soc of Civ Engrs—Oct., 1905. No. 72832 E.

New Graving Dock at Southampton. Brief description, with cross-section, of the recently completed dock for the London and South-Western Railway Company. 1100 w. Engng—Oct. 20, 1905. No. 72877 A.

New Graving Dock at Southampton. Illustrated detailed description of this new dock, which is one of the largest of the kind in Europe and in the world. 1800 w. Engr, Lond—Oct. 20, 1905. No. 72888 A.

Panama.

Conditions at Panama as Seen by a Member of the Consulting Board of Engineers. A letter from Mr. Isham Randolph describing the conditions. 1500 w. Eng News—Oct. 26, 1905. No. 72817.

The First Year's Preparatory Work on the Panama Canal. John F. Wallace. Mr. Wallace's third article gives a summary of the actual construction work accomplished during the year in which he was in charge, and shows the actual costs and the difficulties to be overcome. 4500 w. Engineering Magazine—Nov., 1905. No. 72786 B.

The Present Status of the Panama Canal. Fullerton L. Waldo. A review of the work accomplished, discussing the sites for dams, the plans proposed for sea-level and for lock canals, and the reports of investigators. 4000 w. Eng Rec—Oct. 7, 1905. No. 72483.

Ports.

The Accessibility of Ports. Brysson Cunningham. Discusses the location, environment, approach channel, and climatic conditions in relation to their influence on the accessibility. 3500 w. Engng—Oct. 13, 1905. No. 72683 A.

River Regulation.

The Work of the Commission for the Regulation of the Moldau and the Elbe in Bohemia in 1904 (Die Tätigkeit der Kommission für die Kanalisierung des Moldau und Elbeflusses in Böhmen im Jahre 1904). H. Franz. Details of the progress of the work, with illustrations of locks, movable dams, etc. 3500 w. 1 plate. Oesterr Wochenschr f d Oeffent Baudienst—Oct. 7, 1905. No. 72750 D.

Trieste.

The Improvement of the Harbor of Trieste according to the Projects of 1903 (Ueber die Ausgestaltung des Hafens von Triest nach dem Projekte 1903). Nandor Nadory. A critical discussion of the various plans proposed, pointing out their defects. Serial. Part I. 3000 w. Zeitschr d Oesterr Ing u Arch Ver—Oct. 13, 1905. No. 72783 D.

Venice.

The Port of Venice (Per il Porto di Venezia). A comparative study of the various plans now under consideration for the improvement of the harbor facilities of Venice. 4000 w. Monitore Tecnico—Sept. 20, 1905. No. 72779 D.

Weir.

Constructing a Submerged Weir by Overturning a Tower of Concrete Blocks. Drawings and brief description of a novel scheme devised for a submerged weir in the rapid current of the Niagara River. 400 w. Eng News—Oct. 12, 1905. No. 72497.

MISCELLANY.

Draining.

Drain Tile Laying. Gilmer Siler. The present article considers the essential characteristics of a good drain tile, the various sizes and their capacity of flow, how lands should be drained and best practice in laying tile. 2500 w. Brick—Oct., 1905. Serial. 1st part. No. 72491.

ELECTRICAL ENGINEERING

COMMUNICATION.

Exchanges.

Fire Protection in Telephone Exchanges. H. S. Knowlton. Mentions some practices that deserve criticism, and discusses the necessity for the proper maintenance of fire-protection apparatus. 1800 w. Am Elect'n—Oct., 1905. No. 72383.

Fire Alarms.

Fire Alarm Telegraph Systems. William Brophy. Read before the Int. Assn.

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of Munic. Elect'ns. Suggests some improvements needed, but considers the present system excellent. 5000 w. Ins Engng—Oct., 1905. No. 72825 C.

The Fire-Alarm Telegraph Service in Greater New York. An investigation and report by the committee on fire-alarm service for the borough of Manhattan of the New York board of fire underwriters. Ills. 4500 w. Elec Rev, N Y—Oct. 14, 1905. No. 72527.

Printing Telegraph.

The Siemens & Halske Printing Telegraphic Apparatus. Emile Guarini. Illustrated description of the automatic printing telegraph system recently brought out by this firm. 1100 w. Elec Rev, Lond—Sept. 22, 1905. No. 72308 A.

Space Telegraphy.

Interference in Wireless Telegraphy. John Stone Stone. Abstract of a paper read before the Canadian Soc. of Civ. Engrs. An explanation of the manner of developing persistent trains of simple harmonic electro-magnetic waves of one frequency to the exclusion of waves of other frequencies. 3500 w. Sci Am Sup—Oct. 7, 1905. No. 72447.

Recent Advances in Selective Wireless Telegraphy. Editorial reviewing recent progress in sending messages in a given direction, and inventions of importance in this field. 1100 w. Sci Am—Oct. 17, 1905. No. 72444.

Wireless Telegraphy. W. Duddell. Condensed lecture delivered at Olympia, reviewing the history and referring to the work of various investigators. 3000 w. Elec Engr, Lond—Oct. 6, 1905. No. 72531 A.

Telautograph.

The Telautograph. H. I. English. Brief account of the invention and development of the Gray telautograph, dealing especially with its present commercial form. 3400 w. Jour Fr Inst—Oct., 1905. No. 72605 D.

DISTRIBUTION.

Accumulators.

High Pressure Accumulators (Ueber Hochspannungs-Batterien). L. Schröder. Details of construction and operation of an accumulator charged at 3,000 volts; special reference is made to the insulation. Zeitschr f Elektrotechnik—Oct. 15, 1905. No. 72772 D.

See also Electrical Engineering, Electrochemistry.

Cables.

The Manufacture and Application of Coverings for Cables (Ueber Kabelschützhüllen, deren Herstellung und Verlegung). J. Schmidt. Describing various methods of protecting underground cables from injury, with illustrations and details of costs. 3000 w. Elektrotech Zeitschr—Oct. 5, 1905. No. 72760 B.

Circuit Breaking.

High Tension Circuit Breaking Devices. W. T. Fernandez. Describes the mechanical and electrical features of several types of oil-break switches. Ills. 1600 w. Am Elect'n—Oct., 1905. No. 72386.

Converters.

Recent Converter Installations (Neuere Umformungsanlagen). F. Collischonn. Illustrating and describing several large motor-generators and rotary converters recently erected in Germany. 4000 w. Elektrotech Zeitschr—Sept. 21, 1905. No. 72752 B.

The Cascade Converter. A description of a combination of an induction motor and a synchronous converter. The machine is designed for the transformation of alternating into direct current. Also editorial. 1700 w. Elec Wld & Engr—Oct. 21, 1905. No. 72657.

Discussions.

Discussion on, "High Power Surges in Electric Distribution Systems of Great Magnitude," and "An Experimental Study of the Rise of Potential on Commercial Transmission Lines, Due to Static Disturbances such as Switching, Grounding, etc.," at Asheville, N. C. 7500 w. Am Inst of Elec Engrs—Sept., 1905. No. 72836 D.

Fuses.

Standardization of Enclosed Fuses. H. O. Lacount. Discusses the necessity of standardizing enclosed fuses, the work of standardizing, the results of this work, and the tests of enclosed fuse designed to comply with the specifications. 6000 w. Am Inst of Elec Engrs—Sept., 1905. No. 72842 D.

Reliability.

Discussion on, "Time Limit Relays," and "Duplication of Electrical Apparatus to Secure Reliability of Service," at New York, May 16, 1905. 6000 w. Am Inst of Elec Engrs—Sept., 1905. No. 72855 D.

The Moscow-Road Sub-Station of the Metropolitan Electric Supply Co. Illustrated description. 1500 w. Elect'n, Lond—Oct. 13, 1905. No. 72681 A.

The Westminster Electric Supply Co.'s "Italian Garden" Sub-Station. Illustrated description of a sub-station in Grosvenor-Square, London, where the station is in the basement, and the roof forms the Italian garden, at a level of some 8 ft. above the street. 3700 w. Elect'n, Lond—Sept. 22, 1905. No. 72309 A.

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Substation.

The Monbijou Transformer Station (Die Umformerstation Monbijou). S. Herzog. An illustrated description of the substation in the city of Berne, receiving an alternating current at 16,000 volts from the Kander hydro-electric station, and transforming it to 120 volts continuous for local distribution. 2000 w. Zeitschr f Elektrotechnik—Oct. 8, 1905. No. 72767 D.

Three Wire.

Bare or Insulated Third Wires (Zur Frage des Blanken oder Isolierten Mittelleiters). Fr. Erens. A discussion showing the desirability of insulating the neutral wire in three-wire distribution systems. 3500 w. Elektrotech Zeitschr—Sept. 28, 1905. No. 72756 B.

Notes on Certain Three-Wire Systems. Charles T. Hosman. Read before the Ohio Elec. Soc. Considers points in direct-current lighting and power work. 2500 w. Engr, U S A—Oct. 2, 1905. No. 72345 C.

Transformers.

Calculation of Alternate-Current Transformers for Minimum Cost. Dr. R. Pohl and H. Bohle. Discusses the constructing of a transformer at a minimum cost for a given efficiency. Describes method entirely devoid of mathematical difficulties. 1500 w. Elec Engr, Lond—Sept. 29, 1905. Serial. 1st part. No. 72463 A.

Experience on the Road. G. B. Rosenblatt. An account of an interesting incident with water-cooled transformers, explaining the cause of the trouble. 1200 w. Elect Jour—Oct., 1905. No. 72602.

The Proportions of Transformers Involving a Minimum Cost for Materials (Berechnung von Transformatoren auf den Mindestbetrag an Kosten des Wirksamen Materials). Dr. R. Pohl & Hermann Bohle. Deriving formulas and graphical diagrams for simplifying the practical calculations required for construction. 4000 w. Elektrotech Zeitschr—Sept. 28, 1905. No. 72755 B.

See also Electrical Engineering, Generating Stations.

ELECTRO-CHEMISTRY.

Bichromate Batteries.

A New Form of Cell. Walter P. White. Calls attention to a device for supporting the zinc in such cells. Ills. 700 w. Sci Am Sup—Oct. 21, 1905. No. 72594.

Chemistry.

The Chemistry of Electro-Chemistry. Wilder D. Bancroft. Read before the Am. Elec.-Chem. Soc. A study of electrochemical phenomena with special reference to chemistry. 6000 w. Elec Rev, N Y—Oct. 7, 1905. No. 72434.

Electric Smelting.

Recent Advances in the Electro-Metallurgy of Iron and Steel. R. S. Hutton. Abstract of a paper in *Jour. Soc. of Chem. Ind.* Reviews the electric-furnace methods and what has been accomplished in electric steel production, discussing the outlook. 1300 w. Eng & Min Jour—Oct. 28, 1905. No. 72849.

The Kjellin Electric Steel Furnace. Translated from *Stahl und Eisen.* V. Engelhardt. An illustrated account of the plant at Gysinge, Sweden, and its operation. 4500 w. Ir Age—Oct. 19, 1905. No. 72573.

Electro-Metallurgy.

Some Notes on the Rapid Electro-Deposition of Copper. Sherard Cowper-Coles. Abstract of a paper before the Faraday Soc. Reports results of experiments on the electrolytic production of copper tubes; also considers the production of copper wire by electrolytic means. 900 w. Elec Rev, N Y—Oct. 7, 1905. No. 72435.

The Hoho Process of Heating and Working Metals by Electricity. Paul Hoho. Outlines the principal characteristics of this process, discussing its practical applications. 2200 w. Elec Wld & Engr—Sept. 30, 1905. No. 72389.

Solutions.

Molecules in Solution. Editorial review of paper by G. T. Beilby before the British Assn. Considers some aspects of extreme dilution, and the explanation of the physical properties of liquids. Discusses the case of gold contained in sea water. 2500 w. Engng—Sept. 29, 1905. No. 72473 A.

Storage Batteries.

Storage Batteries and Their Electrolytes. R. W. Vicarey. Abstract of a paper before the Faraday Soc. Gives a résumé of data and facts from actual practice, and much information of value. 8000 w. Elect'n, Lond—Sept. 29, 1905. No. 72470 A.

ELECTRO-PHYSICS.

Dielectrics.

Contact with Dielectrics. Rollo Appleyard. Communicated to the *Philosophical Mag.* by the Physical Soc. A report of experimental investigations with results and conclusions. 4000 w. Elect'n, Lond—Oct. 6, 1905. No. 72542 A.

Eddy-Current Losses.

Eddy-Current Losses in Armature Conductors. Gives details taken from an article in the *Elektrotechnische Zeitschrift*

describing experiments carried out by B. Loewenherz and A. Van der Hoop. Ills. 700 w. Elec Engr, Lond—Sept. 29, 1905. No. 72464 A.

Electromagnets.

The Design of Multiple-Coil Windings. Charles R. Underhill. Explains the principle of the multiple-coil winding for electro-magnets, and the method of ascertaining the safe current carrying capacity of the winding. 1000 w. Elec Wld & Engr—Oct. 14, 1905. No. 72565.

Fog-Dispelling.

Lodge's Fog-Dispelling Apparatus. Abstract of specifications of an invention of Sir Oliver J. Lodge, for "improvements in means for the production of continuous high potential electrical discharges applicable for the deposition of dust, fume, smoke, fog and mist, for the production of rain and for other purposes." 1200 w. Sci Am Sup—Oct. 21, 1905. No. 72593.

Insulation.

Insulating Paints. Arthur B. Weeks. Discusses some of the qualities of a good paint, means of testing, &c. 1800 w. St Ry Rev—Oct., 1905. No. 72638 C.

On the Ratio Between Thickness and Dielectric Strength of High-Tension Insulating Materials. C. Kinzbrunner. Describes experimental investigations. 1500 w. Elect'n, Lond—Sept. 29, 1905. Serial. 1st part. No. 72468 A.

Radium.

Recent Study of Radium. Editorial review of recent papers appearing in the *Philosophical Mag.* giving results of experimental research of much value. 2000 w. Engng—Oct. 20, 1905. No. 72879 A.

GENERATING STATIONS.

Central Station.

The Central Heating and Electric Lighting Station at Dresden. An illustrated account of a central heating station where the results obtained have been exceptionally good. 2200 w. Engr, Lond—Oct. 6, 1905. Serial. 1st part. No. 72550 A.

Combined Plant.

Electric Light, Water Works and Central Hot-Water Heating Installation at Ada, O. A. E. Buchenberg. A general illustrated description of a successful installation. 1600 w. Elec Wld & Engr—Sept. 30, 1905. No. 72388.

Design.

Modern Power-Plant Design and Economics. Franz Koester. Mr. Koester's fourth paper treats of the electrical equipment of the generating room installation and operation. 3000 w. Engineering Magazine—Nov., 1905. No. 72788 B.

The Power Station. Fred N. Bushnell. Read before the Am. Ry. Mech. & Elec. Assn. Also editorial. Discusses problems and development in power station design and operation. Ills. 9800 w. Elec Rev, N Y—Oct. 21, 1905. No. 72653.

Dynamos.

Characteristics of Dynamos. E. B. Raymond. Explains the plotting of curves of series dynamos, shunt dynamos, &c. Diagrams. 1500 w. Engr, U S A—Oct. 16, 1905. No. 72563 C.

Dynamo Heating Time Constants. Explains method of calculation. 600 w. Elec Wld & Engr—Oct. 28, 1905. No. 72857.

Notes on the Design of Continuous-Current Dynamos (Beitrag zum Entwurf von Gleichstrommaschinen). Arthur Müller. A mathematical examination of the controlling elements affecting the proportions of dynamos for continuous currents. 3500 w. Zeitschr f Elektrotechnik—Oct. 1, 1905. No. 72766 D.

The Alternating Current Generator. David B. Rushmore. Historical sketch of the origin, development and present status of this important class of electric generators. Ills. 4500 w. Jour Fr Inst—Oct., 1905. No. 72606 D.

Equipment.

Uniform Equipment in Electric Power Plants. H. S. Knowlton. Presents the advantages of uniform equipment. 1400 w. Cassier's Mag—Oct., 1905. No. 72624 B.

Hartford.

Electrical Supply in Hartford. Describes the Hartford, Conn., system, which derives its energy from the Farmington River, and steam power. Curves are given showing the rise of output since 1898. 1600 w. Elec Wld & Engr—Oct. 21, 1905. No. 72654.

Hydro-Electric.

A Review of the Hydraulic Plant in the Canton of Fribourg, Switzerland (Aperçu Historique des Installations Hydrauliques dans le Canton de Fribourg). F. de Reyff. An illustrated review of the utilization of the mountain streams of the canton, with details of generating and distributing plants. Serial. Part I. 4000 w. Bull Tech de la Suisse Romande—Sept. 25, 1905. No. 72776 D.

The Electric Station of the City of Brixen, on the Rienz (Rienzwerke Elektrizitätswerk der Stadt Brixen). Gustav Witz. With details of the hydraulic and electric plant, turbine regulation, and building construction of the electric plant of Brixen, in Tyrol. 4000 w. 1 plate. Zeitsch d Oesterr Ing u Arch Ver—Oct. 6, 1905. No. 72715 D.

We supply copies of these articles. See page 477.

The Largest Hydroelectric Installation in Southern Asia. A. C. Hobble. Illustrates and describes the interesting engineering features of the Couvery power scheme and the industrial applications in India. 1500 w. Elec Rev, N Y—Oct. 14, 1905. Serial. 1st part. No. 72528.

Water Power Plants on the Apple River, Wisconsin. Illustrates and describes the plant of the Apple River Power Co. comprising two water-power electric generating stations and a high-tension transmission line. The two plants are run in multiple with each other. 3000 w. Eng News—Oct. 12, 1905. No. 72499.

Isolated Plants.

Isolated Plant Engineering. James F. Hobart. Calls attention to points needing attention in such plants, giving suggestions for the best care of the plant. 2200 w. Am Elect'n—Oct., 1905. No. 72385.

Power for Sydney University. E. Kilburn Scott. Read before the Univ. Engng. Soc. Describes a proposed scheme for a power station to meet the needs of the University. 5500 w. Aust Min Stand—Aug. 25, and 30, 1905. Serial. 2 parts. No. 72370 each B.

Lancashire.

Lancashire Electric Power Co.'s System of Generation and Distribution. Illustrates and describes this system which is the first electric power undertaking in England to work with 10,000 volt overhead bare conductors. Also editorial. 3000 w. Elect'n, Lond—Oct. 13, 1905. No. 72682 A.

Load Factor.

The Load Factor of Electric Generating Stations (Der Belastungsfaktor Elektrischer Beleuchtungszentralen). Nörberg Schulz. A discussion of the operation of the generating station at Kristiania, Norway, with load curves and load-factor diagrams. 3000 w. Elektrotech Zeitschr—Oct. 5, 1905. No. 72758 B.

Phase Regulator.

A Proposed Phase Regulator and Its Applications. P. G. Watmough, Jr. Presents only the general principles and applications of the device for adjusting the phase displacement of a generator or other alternating-current apparatus. 1800 w. Elec Wld & Engr—Oct. 21, 1905. No. 72655.

Switch Gear.

The New Ferranti Switch Gear. Illustrates and describes this switch gear, which has been almost entirely remodelled to meet the conditions of modern generating stations. 3000 w. Elect'n, Lond—Oct. 20, 1905. No. 72870 A.

Tunnels.

Latest Electrical Equipment of the Karawanken Tunnel. F. C. Perkins. Describes briefly the electrical power transmission plants and equipments utilized for the construction of this tunnel in Austria-Hungary. 1500 w. Min & Sci Pr—Oct. 21, 1905. No. 72893.

United States.

Central Electric Light and Power Stations in the United States. From a report published by the Bureau of the Census, giving statistics of interest, showing the growth of this industry. 2300 w. Eng Rec—Sept. 30, 1905. No. 72365.

Utah.

The Utah Light & Railway Co. O. A. Honnold. History and description of the engineering and operating features of a system uniting several generating stations by one transmission network. Ills. 5000 w. St. Ry Rev—Oct., 1905. No. 72635 C.

Voltage.

The Selection of Working Voltage for a New Electric Plant (Die Wahl der Verbrauchsspannung für Neu Anzulegende Elektrizitätswerke). E. Wikander. A comparison of the relative advantages of various pressures for continuous and alternating currents. 3000 w. Elektrotech Zeitschr—Oct. 12, 1905. No. 72763 B.

See also Street and Electric Railways.

LIGHTING.

Alternating Arcs.

The Relation Between Current and Voltage in the Alternating Arc. Abstract translation of an article by H. T. Simon. An illustrated study of the arc, showing the necessity of using the dynamic characteristic in considering alternating currents. 2500 w. Elec Engr, Lond—Oct. 20, 1905. No. 72868 A.

Electric Projection.

Some New German Electric Projection Apparatus. C. J. Smith. Illustrates and describes devices for electrical projection of transparent and opaque bodies, as well as for colored projection, combined with searchlight and lantern effects. 1000 w. Elec Wld & Engr—Oct. 28, 1905. No. 72858.

Exhibition.

Recent Progress in Electric Lighting as Indicated by the Olympia Exhibition. Francis H. Davies. Remarks on improvements during recent years, and description of exhibits of various types of lamps. 2000 w. Elec Engr, Lond—Sept. 29, 1905. Serial. 1st part. No. 72461 A.

Lamps.

Notes on the Selection of Incandescent Lamps. J. E. Dawson. Discusses

schemes for the maintenance and renewal of lamps, and the difficulties. 1100 w. Elec Rev, Lond—Oct. 13, 1905. No. 72679 A.

Street Lighting.

Systems of Electric Street Lighting. E. A. Fisher. Read before the Am. Soc. of Munic. Imp. Discusses only the arc lamps, considering the service, cost, &c., giving statistics of the systems in use. 3500 w. Munic Engng—Oct., 1905. No. 72619 C.

Tantalum.

The Tantalum Lamp (Ueber die Tantallampe). W. Wedding. Diagrams and tables of tests, showing the superiority of the tantalum to the carbon incandescent lamp. 2500 w. Elektrotech Zeitschr—Oct. 12, 1905. No. 72762 B.

MEASUREMENT.

Discussion.

Discussion on, "Methods of Measurement of High Electrical Pressures," at Asheville, N. C. 3800 w. Am Inst of Elec Engrs—Sept., 1905. No. 72837 D.

Oscillograph.

The Kathode Ray Oscillograph. Robert Rankin. Describes improvements made in a familiar type of oscillograph which have made it an inexpensive and reliable curve tracer. Gives experiments illustrating its use. Ills. 3000 w. Elec Jour—Oct., 1905. No. 72604.

Photometry.

The Calculation of Mean Spherical Candle Power. Lancelot W. Wild. Describes a method of calculating not generally known. 1200 w. Elect'n, Lond—Sept. 29, 1905. No. 72467 A.

Reichsanstalt.

The Work of the Physical Technical Reichsanstalt in 1904 (Die Tätigkeit der Physikalisch-Technischen Reichsanstalt im Jahre 1904). An abstract of that portion of the report relating to the standardizing of electrical appliances and methods. 6000 w. Elektrotech Zeitschr—Sept. 21, 1905. No. 72754 B.

Self-Induction.

A New Method for Determining Coefficients of Self-Induction (Neues Verfahren zur Bestimmung von Selbstinduktionskoeffizienten). W. Peukert. The attraction between two coils is measured by a beam balance, in connection with a variable capacity and resistance. 1800 w. Elektrotech Zeitschr—Oct. 5, 1905. No. 72759 B.

MOTORS.

Automobile Motors.

Speed-Time Curves for Automobile Motors. Frank B. Rae. Gives curves showing graphically the current input required for a given weight and rate of acceleration and for running at speed, with calculations. 2500 w. Elec Wld & Engr—Oct. 21, 1905. No. 72656.

Discussion.

Discussion on "Synchronous Converters and Motor-Generators," at Asheville, N. C. 4500 w. Am Inst of Elec Engrs—Sept., 1905. No. 72841 D.

Exhibition.

Alternate-Current Machinery at Olympia. P. R. Friedlander. Principally illustrating and describing single-phase and three-phase motors of recent design at the Olympia exhibition. 2000 w. Elec Engr, Lond—Oct. 6, 1905. No. 72530 A.

Direct-Current Machinery at Olympia. P. K. Friedlander. Remarks on the machines shown at the electrical exhibition. Ills. 1800 w. Elec Engr, Lond—Sept. 29, 1905. No. 72460 A.

Induction Motors.

Air-Gap Flux in Induction Motors. A. S. Langsdorf. Report of an investigation made to study the effect upon the flux distribution of varying numbers of teeth in the stator. 1400 w. Am Inst of Elec Egnrs—Sept., 1905. No. 72843 D.

Interpole Motor.

The Morris-Hawkins Inter-pole Motor. Illustrated description of motors which, it is claimed, run sparklessly on all loads with brushes fixed in the neutral position. 800 w. Engng—Sept. 29, 1905. No. 72475 A.

Single-Phase.

Single-Phase Alternating-Current Motors. G. Percy Cole. Abstract of a paper read before the Ohio Elec. Lgt. Assn. Reviews the development of these motors, and describes the Schuler type and the compensated series types for variable speed service. Ills. 2500 w. Engr, U S A—Oct. 2, 1905. No. 72346 C.

Sparking.

Discussion on "Limits of Injurious Sparking in Direct-Current Commutation," at Asheville, N. C. 3000 w. Am Inst of Elec Engrs—Sept., 1905. No. 72840 D.

TRANSMISSION.

France.

A 20,000 Volt Power Transmission Scheme. Illustrated description of a new water-power scheme inaugurated at Clermond-Ferrand, in France. 2500 w. Elect'n, Lond—Oct. 6, 1905. No. 72540 A.

Insulation.

The Testing of High-Pressure Insulating Materials (Die Prüfung von Hochspannungs-Isolationsmaterialien). C. Kins-

brunner. Giving curves showing the time endurance of various insulating materials under different voltages. 2000 w. Zeitschr f Elektrotechnik—Sept. 17, 1905. No. 72764 D.

Lightning Arresters.

Protective Apparatus. N. J. Neall. Illustrates and describes various designs of choke coils for use in connection with lightning arresters. 1400 w. Elec Jour—Oct., 1905. No. 72603.

Long Distance.

The Distribution of Power. Prof. W. E. Ayrton. Abstract of a lecture delivered at the meeting of the British Assn., in South Africa. Reports an interesting lecture in which the use of high-tension continuous current for long-distance transmission is advocated. Also editorial. 6200 w. Elect'n, Lond—Sept. 22, 1905. No. 72310 A.

Mexico.

Development of the Necaxa, Mexico, Water Power. Illustrated detailed description of a great power transmission system, notable for its size and for constructional features of interest. 2000 w. Elec Wld & Engr—Oct. 28, 1905. No. 72856.

Poles.

Cement Feet for Wooden Poles (Zementfüsse für Holzmasten). S. Herzog. Describing a system for protecting the bases of wooden poles from moisture and consequent decay. 1200 w. Zeitschr f Elektrotechnik—Sept. 24, 1905. No. 72765 D.

Single-Phase.

Single-Phase v. Polyphase Transmission Lines. H. S. Watson. Presents arguments in favor of single-phase transmission. 1000 w. Elect'n, Lond—Oct. 6, 1905. No. 72541 A.

MISCELLANY.

Address.

The Influence of Electricity on Power Engineering. W. B. Esson. Presidential address to the Civ. & Mech. Engrs.' Soc. Historical review of the progress and development, with discussion of topics of special interest. 5500 w. Elec Engr, Lond—Oct. 13, 1905. Serial. 1st part. No. 72677 A.

Electric Heating.

The Development of Electric Heating. A. E. Jepson. Abstract of a paper read before the Manchester students' section of the Inst. of Elec. Engrs. Briefly refers to the early applications, the recent development, the various systems in use at the present time, &c. Ills. 5400 w. Mech Engr—Oct. 7, 1905. No. 72538 A.

Electric Shock.

Resuscitation from Electric Shock. E. E. Noble. Read before the Ohio Elec. Lgt. Assn. States some facts learned from experimental investigations, and urges promptness in applying restoratives, giving directions. 2500 w. Cent Sta—Oct., 1905. No. 72436.

Exposition.

Electrotechnics at the Liége Exposition (Die Elektrotechnik auf der Weltausstellung in Lüttich). Dr. M. Corsepius. A general description of the exhibits, with details of lighting devices and transformers. 3500 w. Elektrotech Zeitschr—Oct. 12, 1905. No. 72761 B.

Lightning.

Observations on the Duration of Lightning Flashes (Beobachtungen über die Leuchtdauer der Blitze). K. E. F. Schmidt. A comparison of the observation of various physicists, showing the time to be less than 1 : 30,000 part of a second. 1200 w. Elektrotech Zeitschr—Sept. 28, 1905. No. 72757 B.

INDUSTRIAL ECONOMY

Accounting.

An Accounting System for Mining Supplies. W. M. Jeffery. Read before the Lake Superior Min. Inst. Describes a system that the writer considers the most satisfactory of the various systems under his notice. 4500 w. Ir Age—Oct. 26, 1905. No. 72802.

Charges.

The Financial End of Industrial Engineering. A. E. Dixon. Describes a method for arriving at the fixed charges on an engineering investment, applicable to all investments. 3300 w. Ir Age—Oct. 5, 1905. No. 72387.

Cost-Keeping.

Cost-Keeping for the Foundry. R. W. McDowell. Read before the A. F. A. Convention. Outlines a general system showing the main features of foundry cost accounting. 1400 w. Foundry—Oct., 1905. No. 72632.

Education.

Technical Education for Cincinnati. Herman Schneider. Also editorial. Address before the Cin. Soc. of Mech.

We supply copies of these articles. See page 477.

Engrs. An interesting discussion of the qualifications an engineer should possess and suggestions for the development of such engineers. 3000 w. Am Mach—Vol. 28, No. 42. No. 72582.

Technical Reading and Formulas. C. F. Blake. General remarks on self-education. 1700 w. Mach, N. Y.—Oct., 1905. Serial. 1st part. No. 72377 C.

The College Education of the Engineer. William Kent. Presidential address before the Technology Club, Syracuse, N. Y. Outlines the course of most engineering colleges, discussing the results, and giving opinions of prominent educators and critics. 4700 w. Eng News—Oct. 19, 1905. No. 72590.

The Education of Mining Engineers. J. B. Porter. Abstract of a lecture at Kimberley. Discusses the extent to which practical and technical training should enter into an engineering education, outlining a course recommended. 3000 w. Engng—Oct. 13, 1905. No. 72689 A.

Exposition.

The Exposition at Milan in 1906 (Esposizione di Milano 1906). A preliminary account of the buildings and general arrangement of the exposition to be held at Milan in 1906 to celebrate the opening of the Simplon tunnel. 3000 w. Monitore Tecnico—Sept. 10, 1905. No. 72778 D.

Factory Sites.

Kettering. Description and information concerning the advantages of this English town for manufacturing works. Editorial. 6500 w. Engng—Sept. 22, 1905. No. 72312 A.

Great Britain.

Great Britain's Iron Industry. T. Good. Discusses the production, imports, exports, &c., from a British point of view. 3000 w. Cassier's Mag—Nov., 1905. No. 72989 B.

Japan.

Engineering Science in Japan. Robert H. Smith. Reviews some of the interesting papers recently presented to the Society of Mechanical Engineers, Tôkyo, showing the remarkable progress in this field. 3300 w. Engr, Lond—Sept. 22, 1905. No. 72321 A.

Labor.

An Unique Trade Union. A résumé of the plan of organization instituted by E. J. Smith, and in operation in Birmingham, England. 2500 w. Am Mach—Vol. 28, No 44. No. 72950.

Comfortable Homes in Europe. Illustrations and information concerning the several types of houses and villages constructed for the comfort of those employed in the Krupp works. Comparison is made with the homes of American and British workmen. 4000 w. U S Cons Repts—Sept., 1905. No. 72900 D.

Relations Between Employer and Employed. Francis L. Robbins. Address before the Merchants' and Manufacturers' Assn. An explanation of methods of the Pittsburg Coal Co., which enables their employees to share in the profits. 2000 w. Marine Rev—Oct. 26, 1905. No. 72845.

The Pennsylvania Anthracite Law. R. W. Raymond. Quotes this law, showing that its purpose is to put the anthracite operators at the mercy of the labor unions, and suggests measures that would remove the objectionable features. 1800 w. Eng & Min Jour—Oct. 7, 1905. No. 72433.

The Relations between the Employer and Employed (Verhältnis swischen dem Arbeitgeber und dem Arbeiter). R. Krause. An examination of labor conditions in Germany, discussing especially welfare work and the maintenance of friendly relations between employer and men. 2000 w. Stahl u Eisen—Oct. 1, 1905. No. 72725 D.

Welfare Work. Information of what is being accomplished in this work, taken from statements made by H. H. Vreeland, before the New England Cotton Mfrs. Assn. 1700 w. Eng Rec—Sept. 30, 1905. No. 72364.

Ownership.

Governmental vs. Private Ownership of Public Utilities. Reviews the history of the State of Illinois, which records repeated failures wherever and whenever governmental ownership has been tried. 4000 w. R R Gaz—Vol. XXXIX, No. 14. No. 72405.

Shop Methods.

Manufacturing Methods. C. L. Goodrich. A detailed description of a system of preparing, in advance of the machine work, detail contract slips to assist in keeping workmen constantly employed on the class of work in which they are most efficient. 1200 w. Ir Age—Oct. 26, 1905. No. 72801.

Shop System for Electrical Contractors. Louis J. Auerbacher. Describes a system suitable for a concern doing a general contracting and jobbing business and employing from 15 men upwards. 2300 w. Am Elect'n—Oct., 1905. No. 72384.

Strike.

Recent Strike and Lock-Out in Berlin. H. S. Meyer. A review of the causes of this strike and lock-out of about 40,000 workmen. 900 w. Elect'n, Lond—Oct. 20, 1905. No. 72871 A.

We supply copies of these articles. See page 477.

MARINE AND NAVAL ENGINEERING

Boilers.

See Mechanical Engng., Steam Engng.

Car Ferry.

East Ivory Car Ferry of the Missouri Pacific. Illustrated description of a car ferry crossing the Mississippi River about six miles below the Eads Bridge, used for the transfer of freight cars. 1200 w. R R Gaz—Vol. XXXIX, No. 15. No. 72511.

Destroyer.

The Swedish Torpedo-Boat Destroyer "Magne." Illustration, with brief notes comparing with an earlier vessel for the Swedish Government. 350 w. Engng—Sept. 29, 1905. No. 72476 A.

Floating Dock.

The Self-Docking Steel Floating Dry-Dock Dewey. Illustrated detailed description of this large dry-dock built for service in the Philippine Islands. 2800 w. Marine Engng—Oct., 1905. No. 72334 C.

Gas Propulsion.

See Mechanical Engineering, Combustion Motors.

Gliding Boats.

Gliding Boats—The Navigation of the Future. Prof. Daniel Bellet. Gives an illustrated description of Count de Lambert's boat, explaining its principle, and mentioning some other attempts to glide over the water. 1600 w. Sci Am—Oct. 7, 1905. No. 72446.

Ice Yacht.

Improved Ice Yacht Construction. H. Percy Ashley. Describes what is considered the most satisfactory construction. Hollow back bones and 250-sq. ft. sail area. Ills. 1000 w. Sci Am Sup—Oct. 27, 1905. No. 72818.

Jet Propulsion.

A Jet-Propelled Boat. Brief description of the jet propeller invented by Mr. Rankin Kennedy, with diagram. 900 w. Prac Engr—Sept. 29, 1905. No. 72455 A.

Lake Vessels.

Modern Lake Cargo Carriers. Illustration, and description of the Sylvania, one of this season's new boats. 1700 w. Naut Gaz—Oct. 19, 1905. No. 72633.

Lifeboat.

The Twin-Screw Steam Lifeboat "Molesey." Brief illustrated description of the fastest steam lifeboat yet built, and the only one fitted with twin screws. 350 w. Engng—Sept. 22, 1905. No. 72315 A.

Naval Engineers.

The Engineering Personnel of the United States Navy. William Ledyard Cathcart. A critical discussion of the disaster on the U. S. Gunboat "Bennington," and the effect of the Personnel Act upon the efficiency of the engineering service in the navy. 2500 w. Cassier's Mag—Oct., 1905. No. 72626 B.

The Naval Personnel Act and Its Results. J. Snowden Bell. Gives the provisions of the act, and the conditions leading up to it, discussing its purpose, advantages, &c. 6000 w. Am Mach—Vol. 28, No. 42. No. 72579.

Ore Carrying.

The "Elbert H. Gary"—The Greatest of Ore-Carrying Steamers. W. Frank M'Clure. Illustrates and describes one of the four mammoth cargo steamers recently built for the Great Lakes. 700 w. Sci Am—Oct. 14, 1905. No. 72501.

Philippines.

Shipping of the Philippine Islands. H. B. M'Coy. A discussion of the present shipping conditions and the possibilities. 2200 w. Marine Rev—Sept. 28, 1905. No. 72333.

Repairs.

Interesting Repair Work on a German Steamship. Dr. Alfred Gradenwitz. Illustrates and describes repair work on the alumina thermic process on the sternpost of the "Frederick der Grosse." 600 w. Sci Am—Oct. 21, 1905. No. 72592.

Rudders.

Notes on the Calculation of Size of Rudder Stocks. J. W. Clary. Explains the theory of these calculations, giving the results of tests from ships in service, and deriving formulae which may be quickly applied. 4000 w. Marine Engng—Oct., 1905. No. 72335 C.

Shipbuilding.

The Development of the German Shipbuilding Industry (Die Entwickelung der Deutschen Schiffbau Industrie). F. Stellter. A review of the growth of the industry since 1873, with tables and diagrams. Serial. Part 1. 3000 w. Schiffbau—Oct. 11, 1905. No. 72769 D.

Signaling.

Cunard Line and Submarine Signaling. Brief illustrated description of the system devised by the Submarine Signal Co. of Boston, for signaling through the water, and lately tested on the Cunard steamer "Lucania." 600 w. Marine Rev—Oct. 5, 1905. No. 72424.

We supply copies of these articles. See page 477.

J. B. Millet's Submarine Signaling System (J. B. Millet's Unterwasser Signaleinrichtungen). Th. Karrass. Describing the successful application of the microphone to the reception of distant bell signals under water. 2000 w. Elektrotech Zeitschr—Sept. 21, 1905. No. 72753 B.

Some Recent Developments in Submarine Signalling. Alfred Gradenwitz. Illustrates and describes the invention of Arthur J. Mundy for sending sound through the water, and some of its applications. 2000 w. Elec Rev, Lond—Sept. 29, 1905. No. 72465 A.

Steamships.

The New Trans-Atlantic Steamship Amerika. Illustrates this new ocean passenger steamship of the Hamburg-American line, describing its novel features. 1400 w. Naut Gaz—Oct. 26, 1905. No. 72846.

The Passenger and Freight Screw-Steamer Kong Haakon. Dr. Alfred Gradenwitz. Illustrates and describes a screw steamer built in Germany, for a Norway company, and is intended to convey passengers and mail between various coast stations. 1200 w. Marine Engng—Oct., 1905. No. 72336 C.

Iron and Steel Hull Steam Vessels of the United States. J. H. Morrison. Reviews the history of iron and steel in hull construction. 4200 w. Sci Am Sup—Oct. 21, 1905. Serial. 1st part. No. 72597.

Steering Gear.

The Electric Steering Gear of the Turbine Steamer "Manxman." Illustrated description of the design and principle of the electrical equipment. The installation is a combination of steam and electric power, either being used as desired, or the vessel may be steered by hand. 1400 w. Sci Am Sup—Oct. 7, 1905. No. 72449.

Submarine.

The First Submarine Boat Built in the Netherlands (De Eerste in Nederland Gebouwde Onderzeesche Torpedo-boote). Illustrated description of a boat built at the Government works on the Schelde from plans of the American Electric Boat Company. 3000 w. De Ingenieur—Sept. 16, 1905. No. 72780 D.

Tow Barge.

Evolution of the Tow Barge. John R. Spears. Reviews the history of the use of the tug and the tow barge, and the future outlook for such transportation. 2000 w. Sci Am—Oct. 14, 1905. No. 72500.

Warships.

The Damaged Russian Warships at Port Arthur. Gives a detailed report of the damage, with comments. 3000 w. Engng—Oct. 20, 1905. No. 72881 A.

MECHANICAL ENGINEERING

AUTOMOBILES.

Argyll.

The 1905 Argyll Cars. Information concerning these vehicles and their manufacture. Ills. 2300 w. Auto Jour—Oct. 14, 1905. Serial. 1st part. No. 72667 A.

Clutches.

Some New Expanding Clutches. Brief illustrated descriptions of the Dombret clutch, the Herisson clutch, the Gillet-Forest, and the Julien clutch. 2000 w. Mech Engr—Oct. 7, 1905. No. 72537 A.

Commercial Vehicles.

Industrial Automobiles. A. Frederick Collins. Illustrates and describes some interesting English vehicles of this class. 2000 w. Sci Am Sup—Oct. 14, 1905. No. 72502.

Gears.

The Mitchell Epicyclic Gear. Diagrams and description showing the design and method of this gear. 1200 w. Autocar—Oct. 14, 1905. No. 72670 A.

Ignition.

Magneto Ignition. An illustrated series of articles explaining low- and high-tension magneto ignition. 3500 w. Autocar—Oct. 14, 1905. Serial. 1st part. No. 72669 A.

Mercedes.

A 1906 Mercedes Car—The New 70-H. P. Model. Begins an illustrated description of this new model, and the new features introduced. 2000 w. Auto Jour—Sept. 30, 1905. Serial. 1st part. No. 72451 A.

Motor Vehicles.

The Agricultural Application of the Gasoline Automobile. Notes various applications recently made in England for agricultural purposes, illustrating the Noel motor used as a thresher and at work in a field. 900 w. Sci Am Sup—Oct. 21, 1905. No. 72596.

Omnibus.

40-H. P. Gardner-Serpollet Motor-Omnibus. Illustrates and describes a ve-

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hicle carrying thirty passengers which is to be put on trial in Paris. 1200 w. Engng—Oct. 20, 1905. No. 72882 A.

Pierce.

Pierce 1906 Model Touring Cars. Illustrates and describes these cars. A feature is the liberal use of ball bearings. 1700 w. Automobile—Oct. 26, 1905. No. 72821.

Punctures.

Repairing a Puncture—A Modern Method. Illustrates and describes details in the process of effecting a vulcanized repair to an inner tube. 1100 w. Auto Jour—Sept. 23, 1905. Serial. 1st part. No. 72306 A.

Racing.

France Wins the Vanderbilt Cup. A collection of illustrated articles describing the race and the performance of the cars, and giving information of interest. 24000 w. Automobile—Oct. 19, 1905. No. 72601.

The Vanderbilt Cup Elimination Race. Illustrates eight of the ten machines which competed, giving brief descriptions and information of interest. 3500 w. Sci Am—Oct. 7, 1905. No. 72445.

The Winning Cars in the Tourist Trophy Race. A description of the winning Arrol-Johnston car, and the second and third cars of this race on the Isle of Man. Ills. 2200 w. Sci Am Sup—Oct. 21, 1905. No. 72598.

Regent.

The 18-H. P. Regent Car. Begins an illustrated detailed description of a moderate priced car. 800 w. Auto Jour—Oct. 7, 1902. Serial. Part I. No. 72534 A.

Second-Hand Cars.

The Examination of Second-Hand Cars. Gives some experiences of an expert examiner. 2000 w. Autocar—Sept. 30, 1905. Serial. 1st part. No. 72453 A.

Spring Wheel.

The Empire Spring Wheel. The present number explains the principle of the wheel. Ills. 1300 w. Auto Jour—Oct. 7, 1905. Serial. 1st part. No. 72535 A.

Steam.

An 18-H. P. White Steam Car—The 1906 Model. Illustrates and describes this new model, dealing with the novel features which have been embodied. 1700 w. Auto Jour—Sept. 30, 1905. No. 72452 A.

Tourist Trophy.

The Tourist Trophy Race Question. Gives a summary of the articles this paper has published relating to the race, and gives a report of the engine tests made. 2000 w. Auto Jour—Oct. 14, 1905. Serial. 1st part. No. 72668 A.

Vibration.

The Vibration of Automobile Motors. (Die Erschütterungen bei Automobilmotoren). Th. Lembeck. An examination of the inertia forces acting to produce vibration, and a discussion of the disposition of cylinder action to minimize vibratory action. 4500 w. Zeitschr d Mitteleurop Motorwagen Ver—Sept. 30, 1905. No. 72777 D.

COMBUSTION MOTORS.

Diesel.

Trials of a 500 B. H. P. Diesel Oil Engine. Michael Longridge. Describes trials and gives results in tables and diagrams. 1500 w. Mech Engr—Oct. 14, 1905. Serial. 1st part. No. 72674 A.

Gas Engines.

Design, Construction and Application of Large Gas Engines in Europe. Franz Erich Junze. The first of a series of articles dealing with types of engines which have been built and shown results. Considers the two-cycle problem. 3300 w. Power—Nov., 1905. Serial. 1st part. No. 72863 C.

Notes on the Design of Large Gas Engines with Special Reference to Railway Work. Arthur West. Read before the Am. Ry., Mech. & Elec. Assn. Discusses important considerations in the design of large gas engines, and some of the differences in European and American designs. Ills. 2000 w. St Ry Jour—Sept. 30, 1905. No. 72355 C.

The Strang Gas Engine. Illustrates and describes a four-cycle double acting gas engine in which a portion of the exploded charge is mingled in the mixing chamber with the new charge, and returned to the engine. The object is economy. 1200 w. Ir Age—Oct. 12, 1905. No. 72490.

Gasoline Engine.

The Excelsior Reversing Gasoline Engine. Illustrates and describes a two-cycle engine having original features, especially the mechanism for reversing without the use of intermediate gearing. 1500 w. Ir Age—Oct. 26, 1905. No. 72800.

Gas Plant.

Pumping Plant for Sprinkler Supply (Usine Elévatoire pour l'Arrosage). Describing suction producer gas pumping plant for raising water for sprinkling the Tremblay race course. 1500 w. 1 plate. Génie Civil—Oct. 7, 1905. No. 72711 D.

Ignition.

Timing the Ignition in Internal Combustion Engines. Shows the importance of correct timing in regard to economy and power developed. 900 w. Prac Engr—Sept. 22, 1905. No. 72307 A.

We supply copies of these articles. See page 477.

Marine Propulsion.

The Application of Combustion Motors to War Ships (Verwendbarkeit von Verbrennungsmotoren zur Fortbewegung Moderner Kreigsschiffe). Lieut. Philippow. A translation from the Russian, showing the practicability and advantages of combustion motors for marine service, with special reference to the Diesel motor. Serial. Part I. 3500 w. Schiffbau—Oct. 11, 1905. No. 72770 D.

Producer Gas.

Lignite Producer-Gas Plants. Dr. Alfred Gradenwitz. Illustrated description of a plant constructed by the Deutz Gas Motor Works, where the tars are decomposed in the producer. 1600 w. Sci Am Sup—Oct. 14, 1905. No. 72506.

HEATING AND COOLING.

Air Pipes.

Air Pipes, Sizes Required for Low Velocities. Considers the pressures required under varying conditions, methods of designing systems of piping, giving table, and examples illustrating its use. 3000 w. Heat & Vent Mag—Oct., 1905. No. 72612.

Armory.

Heating System of the Squadron C Armory, Brooklyn, N. Y. J. Byers Holbrook. Describes the building, which has a large riding hall, as well as the usual administration section and usual armory conveniences. The heating is on the two-pipe, up-feed, low pressure, direct radiation system. 1400 w. Eng Rec—Oct. 14, 1905. No. 72571.

Gas Heating.

Gas Heating Plant. Ernest A. Dowson. Abstract of a paper read before the Birmingham Assn. of Mech. Engrs. Illustrates and describes some applications of gaseous fuel to heating, discussing methods. 1800 w. Ir & Coal Trds Rev—Oct. 6, 1905. No. 72544 A.

Heating Plant.

Steam Tube Heater for Hot Water Heating Plant. A problem requiring the calculations for the size of a heater for warming the water of a hot water heating plant by means of steam, with the method of solving it. 2500 w. Met Work—Oct. 7, 1905. No. 72411.

Hot Blast.

Hot Blast Heating and Ventilation. W. G. Bissell. Gives results of experiments on hot blast apparatus. 1000 w. Iowa Engr—March, 1905. No. 72834 C.

Hot Water.

Hot Water Heating and House Drainage in a Residence in Ellenville, N. Y. Floor plans and sectional elevation, with description of heating and plumbing systems. 2500 w. Met Work—Oct. 7, 1905. No. 72410.

Hot-Water Heating by Single-Pipe System with Secondary Circulation. (Warmwasserheizung, Einrohrsystem mit Sekundärer Zirkulation). O. Krell. A single large main is used, the radiators being placed in shunt circuits. The system is worked out in detail. Serial. Part I. 9000 w. Gesundheits-Ingenieure—Sept. 20, 1905. No. 72771 D.

Overhead versus Underfeed in Hot Water Heating. Konrad Meier. Discusses five examples intended to represent different conditions occuring in practice. Diagrams. 1800 w. Heat & Vent Mag—Oct., 1905. No. 72611.

The Principles of Hot Water Circulation. F. C. Cook. The systems in common use for heating and distributing hot water in an ordinary dwelling-house are discussed, with sketches of the appliances used. 1400 w. Plumb & Dec—Oct. 2, 1905. No. 72533 A.

Refrigeration.

Mechanical Refrigeration. W. W. Edwards. Introduction, explaining the principles of refrigeration, and an illustrated description of the Allen dense air machine and its operation is given in the present number. 2500 w. Engr, U S A—Oct. 2, 1905. Serial. 1st part. No. 72344 C.

The Production of Very Low Temperatures. (Production des Très Basses Températures). A. Lafay. A review of the methods employed in the liquefaction of air and of hydrogen, with illustrations of the apparatus. Serial. Part I. 2500 w. Génie Civil—Sept. 23, 1905. No. 72708 D.

Residence.

Heating and Ventilating a City Residence. Describes a type of indirect heating installed in a residence in New York City. Ills. 1400 w. Heat & Vent Mag—Oct., 1905. No. 72613.

HYDRAULICS.

Air Lift.

The Theory of the Air Lift. An explanation of the theory of operation of this apparatus for lifting water from wells. 1100 w. Compressed Air—Oct., 1905. No. 72827.

Centrifugal Pumps.

Results of Tests of a Forced Vortex Centrifugal Pump. Prof. A. Inokuty. Abstract from the Jour. of the College of Engng., Tokio, Japan. Gives results of tests made of a 7-in. forced vortex centrifugal pump. 700 w. Ills. Prac Engr—Sept. 29, 1905. No. 72454 A.

Turbine Power Station and Centrifugal Pumping Plant at the Holland Mine at

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Wattenscheid (Dampfturbinen-Zentrale und Zentrifugal-Wasserhaltung auf Zeche Holland, Schacht I, II, bei Wattenscheid). H. Weitzenmiller. A Rateau steam turbine is directly connected to the dynamo, and the pumping is done by multiple centrifugal pumps driven by electric motors. 2500 w. Glükauf—Sept. 16, 1905. No. 72735 D.

Hydraulic Presses.

Cartridge Case Heading and Indenting Press. Illustrates and describes a hydraulic press for heading and indenting the cartridge cases of quick-firing ammunition. 900 w. Engng—Oct. 6, 1905. No. 72546 A.

Hydraulic Pressing, Stamping and Forging Machinery. F. W. Steele. Read before the Liverpool Engng. Soc. Discusses the designing and its importance, especially of the valves and piping, the velocity of the water through pipes and valves, etc., in this number. 2200 w. Mech ngr—Sept. 30, 1905. Serial. 1st part. No. 72459 A.

Pelton Wheel.

Pelton Wheel with Adjustable Nozzle for the Glyn Slate Company. Illustrated description of a Pelton wheel fitted with a new pattern of variable-discharge nozzle. 600 w. Engng—Oct. 13, 1905. No. 72688 A.

Pumping Engines.

Pumping Engines of the Budapest Water-Works. Illustrates and describes the fly-wheel engines installed to meet the great differences in the consumption of water occurring several times a day. 2200 w. Engr, Lond—Sept. 22, 1905. No. 72322 A.

Rams.

Hydraulic Rams and Pumps. Henry H. Clay. Their construction and uses, with sketches showing their working parts, and descriptive rules for finding the sizes for raising given quantities of water. 1700 w. Plumb & Dec—Oct. 2, 1905. No. 72532 A.

"Sea Mills."

The "Sea Mills" of Cephalonia. William P. Mason. Brief description of mills equipped with undershot wheels which are driven by sea-water flowing landward from the coast. Ills. 300 w. Eng News—Oct. 5, 1905. No. 72403.

Stream Power.

Power Capacity of a Running Stream Without Storage. Reviews Prof. Raymond's analysis of the conditions, as given in a paper before the Iowa Engng. Soc. 1200 w. Eng Rec—Sept. 30, 1905. No. 72360.

Turbines.

The Theory and Computations for Turbines and Centrifugal Pumps (Theorie und Berechnung der Vollturbinen und Kreiselpumpen). H. Lorenz. A mathematical discussion of the curves of turbines of the Francis type, deriving formulas also applicable to centrifugal pumps. 4000 w. Zeitschr d Ver Deutscher Ing—Oct. 14, 1905. No. 72732 D.

MACHINE WORKS AND FOUNDRIES.

Air Furnaces.

Types of Air Furnaces. L. G. Blunt. Brief illustrated descriptions of the three principal types in use in the United States, with remarks on the difference in fuel consumption. 600 w. Foundry—Oct., 1905. No. 72628.

Castings.

Gating Malleable Castings. Jean P. Fermal. Information on methods of gating that have given successful castings. 1800 w. Foundry—Oct., 1905. No. 72631.

Notes on Bronze Castings. An illustrated article pointing out the importance of considering thermal conditions, and the suitability of certain alloys for certain classes of work. 1700 w. Ir & Coal Trds Rev—Oct. 13, 1905. No. 72693 A.

Steel Castings and the Constitution of Steel. Percy Longmuir. On the effect of carbon, manganese, silicon, sulphur, and phosphorus. Ills. 1500 w. Foundry—Oct., 1905. No. 72630.

The Preparation of Molds for Steel Castings. Arthur Simonson. Read before the Phila. Found. Foremen's Assn. Discusses molding materials, mixing, the mechanical properties of the mold, core making, &c. 2700 w. Ir Age—Oct. 19, 1905. No. 72574.

Chips.

Is the Constitution of Chips from High-Speed Steel the Same as from the Older Cutting Tools? (Sind die Schnelldrehspäne ebenso Aufgebaut wie die mit den Alten Messern Genommenen?) Max Kurrein. With microphotographs and results of tests, showing the nature of the cuttings to be the same in both cases. 3500 w. 1 plate. Oesterr Wochenschr f d Oeffent Baudienst—Sept. 16, 1905. No. 72748 D.

Cores.

Core Practice and Sands Used for Cores in Various Parts of the Country. R. H. Palmer. Describes sands used in various parts of the United States, the construction of cores, and discusses core compounds. 1800 w. Am Mach—Vol. 28, No. 40. No. 72395.

Cost Keeping.

See Industrial Economy.

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Crane Drums.

The Construction of Crane Drums. Joseph Horner. Illustrations and discussion of plain drums, grooved drums, &c., and their manufacture. 1600 w. Am Mach—Vol. 28, No. 40. No. 72396.

Crank-Press.

A Machine-Shop Crank-Press. Illustrates and describes a machine re-invented and re-designed by William A. Box. 600 w. Am Mach—Vol. 28, No. 42. No. 72578.

Cutting.

The Cutting Capacity of Power Presses. E. W. Zeh. Treats only power presses driven direct by the flywheel without the aid of gearing, in the present article, developing formulas. 1400 w. Am Mach—Vol. 28, No. 41. No. 72495.

Drilling Machine.

High-Speed Radial Drilling and Tapping Machines. Illustrates and describes machines designed to meet the requirements as to speed, power, and stiffness called for in the use of modern high-speed tool steel. 1000 w. Engng—Sept. 29, 1905. No. 72474 A.

Floors.

Machine Shop Floors. From *Woodcraft*. Gives the ideas of a number of prominent engineers on the wearing quality of shop floors. 2500 w. Ir Trd Rev—Oct. 26, 1905. No. 72698.

Foundry.

A Large Modern Iron Foundry. Samuel Groves. A brief description of the plant at Trafford Park, England, of the British-Westinghouse Electric & Manufacturing Co. Ills. 1800 w. Can Engr—Oct., 1905. No. 72492.

Foundry Department of the Port Huron Engine and Thresher Co., Port Huron, Mich. Illustrated detailed descriptions of the three foundry plants and their work. 2200 w. Foundry—Oct., 1905. No. 72627.

Gages.

A Set of Accurate Test and Inspection Gages for Small Duplicate Work. Joseph V. Woodworth. Illustrates and describes a set of four tests and inspection gages for verifying measurements of small, accurately machined steel parts. 1400 w. Mach, N Y—Oct., 1905. No. 72379 C.

Gear Cutting.

Cutting Spiral Gears. E. H. Fish. Gives an explanation of a method of figuring these gears, which involves a minimum amount of mathematics. 2500 w. Mach, N Y—Oct., 1905. No. 72376 C.

Hack-Saws.

Recently Designed English Power Hack-Saws. James Vose. Illustrated descriptions of machines for stock up to five-inch diameter, and for stock up to ten-inch diameter. 800 w. Am Mach—Vol. 28, No. 42. No. 72580.

Lathes.

Lathe Design and Practice. E. H. Fish. The present number discusses the cause of chattering, the main spindle bearing, the carriage, and the carriage ways. Ills. 2500 w. Am Mach—Vol. 28, No. 41. Serial. 1st part. No. 72494.

The Ridgway Heavy Driving Wheel Lathe. Illustrated description of a 90-in. heavy driving wheel lathe, with a report of tests of its efficiency. 1800 w. Ir Age—Oct. 26, 1905. No. 72699.

Mechanical Plant.

Plant of the Port Huron Engine & Thresher Co., Port Huron, Mich. Illustrated detailed description of a plant especially noted for the manufacture of high class traction engines. 3000 w. Ir Trd Rev—Oct. 5, 1905. No. 72391.

Moulding.

Molding (in One Piece) a 15-Foot Fly-Wheel in Dry Sand Cores. S. B. Ryder. Illustrates and describes the methods used. 800 w. Am Mach—Vol. 28, No. 42. No. 72583.

Sheave Wheel Molding. R. Davis. Considers the webbed wheel with plain groove, the spoke wheel with plain groove, and the wheel with toothed groove for chain, explaining how each should be prepared for molding. Ills. 2000 w. Am Mach—Vol. 28, No. 40. No. 72398.

Patterns.

The Foundryman's Patternmaker. Paul R. Ramp. Showing the importance of having the foundry foreman competent to determine the proper method of molding and of having the pattern department under his control. Ills. 1200 w. Foundry—Oct., 1905. No. 72629.

Pipe.

The History and Manufacture of Drawn Gas Pipe (Geschichte und Fabrikation Gezogener Gasröhre). Anton Bousse. A review of the earlier processes for making lap-welded pipe, and a description of the machinery and methods of manufacturing drawn tubing. Serial. Part I. 3500 w. Stahl u Eisen—Oct. 1, 1905. No. 72721.

Planing Machines.

Turbine Planing Machine. Illustrated detailed description of a pit-type planing machine for turbine construction. 500 w. Engr, Lond—Oct. 13, 1905. No. 72692 A.

New Automatic Reversing Gear for Electrically-Driven Planers. J. William Chubb. Illustrated description of a sys-

tem devised by Vickers, Sons and Maxim, Ltd., which consists of a variable-speed motor combined with special switches mounted on the planer and worked from the driving gear. 900 w. Am Mach—Vol. 28, No. 40. No. 72397.

Riveting.

Notes on Workmanship in Riveting. A. J. Himes. A discussion of points in riveting and the testing of rivets. 1600 w. Eng News—Oct. 19, 1905. No. 72589.

Shears.

Improved Electric Block Shears (Neue Elektrisch Betriebene Blockscheren). A. Schwarze. Illustrating and describing shears for cutting hot billets and blocks of steel, arranged for electric driving. Serial. Part I. 3000 w. 1 plate. Stahl u Eisen—Oct. 15, 1905. No. 72729 D.

Shop Methods.

See Industrial Economy.

Shops.

Messrs. Richardsons, Westgarth, and Co's Steam-Turbine Works, Hartlepool. Illustrates and describes a new department recently completed at the Hartlepool Works, and some of the steam-turbines manufactured. 3500 w. Engng—Oct. 13, 1905. No. 72684 A.

The Henry R. Worthington Hydraulic Works. Illustrated detailed description of the new plant at Harrison, N. J. 5000 w. Ir Age—Oct. 12, 1905. No. 72489.

The New Shops of the Watson-Stillman Co. Illustrates and describes this new plant at Aldene, N. J., used for the manufacture of hydraulic machinery. 3000 w. Eng Rec—Oct. 14, 1905. No. 72568.

Speed Control.

Electrical vs. Mechanical Speed Control. Notes the most common mechanical methods used, and the methods used for electrical control, comparing the working, cost, advantages, &c. 4800 w. Engr, U S A—Oct. 16, 1905. No. 72564 C.

Springs.

The Modification of Spring Action by Toggle Joints. E. H. Fish. Illustrated description of a combined spring and toggle joint mechanism. 1000 w. Am Mach—Vol. 28, No. 43. No. 72822.

Symboling.

A Symboling System for Machine Parts. W. Bancroft. Explains a method devised by the Monotype Company to designate the parts of its type-casting and composing machine. This machine contains 2,028 parts. 2500 w. Am Mach—Vol. 28, No. 42. No. 72581.

Tapping Machine.

A Three-Spindle Tapping Machine. John Tangye. Elevation and plan, with description. 2200 w. Prac Engr—Oct. 20, 1905. No. 72867 A.

Waste.

Exhaust Pipe System for Removing Waste Material. M. L. Kaiser. An illustrated series of articles on the details of exhaust pipe work in factories, mills, and shops. The present article deals with a shavings exhaust plant for a planing-mill. 1300 w. Met Work—Oct. 21, 1905. Serial. 1st part. No. 72614.

MATERIALS OF CONSTRUCTION.

Alloys.

A Study of Copper-Aluminum Alloys (Etude Théorique et Industrielle des Alliages de Cuivre et d'Aluminum). L. Guillet. With diagrams and microphotographs showing the properties of the various copper-aluminum alloys, indicating those of industrial value. 5000 w. Revue de Métallurgie—Aug., 1905. No. 72784 G.

The Constitution of the Copper-Aluminum Alloys (Constitution des Alliages Cuivre-Aluminium). Léon Guillet. An examination of the various solid solutions existing in the industrial alloys of copper and aluminum, and a discussion of their properties. 1200 w. Comptes Rendus—September 4, 1905. No. 72717 D.

Corrosion.

A Study of the Corrosion of Condenser Tubes. A. Humboldt Sexton. A critical examination of the behavior of brass tubes in contact with sea water, with regard to the causes and possible prevention of corrosion. 4500 w. Engineering Magazine—Nov., 1905. No. 72790 B.

The Corrosion of Copper by Sea Water (La Corrosion du Cuivre par l'Eau de Mer). A review of the tests made by the German Navy, with discussion of the methods of prevention of corrosion. 2000 w. Génie Civil—Sept. 23, 1905. No. 72710 D.

Lubricants.

Selection of Oils. A. O. Towney. Suggestions for the selection of the right oils. 1000 w. Engr, U S A—Oct. 2, 1905. No. 72347 C.

Packings.

Metallic Packings. R. T. Strohm. States the advantages of metallic packings, and illustrates and describes several forms. 3000 w. Am Elect'n—Oct., 1905. No. 72382.

Rivets.

The Shearing Strength of Rivets. E. S. Fitzsimmons. Read at convention of Mas. Steam Boilermakers. Describes tests made and results. 1200 w. Ir Trd Rev—Oct. 5, 1905. No. 72392.

We supply copies of these articles. See page 477.

Special Steels.

Steels Especially Used in Automobile Construction (Aciers Spéciaux Employés en France dans la Construction des Automobiles). Léon Guillet. Discussing especially nickel, chrome, and silicon steels. 3000 w. Génie Civil—Oct. 7, 1905. No. 72712 D.

Steel Used for Motor Car Construction in France. Léon Guillet. Read before the Ir. & Steel Inst. Discusses in detail the chief special steels actually employed in the motor car industry. 4500 w. Ir & Coal Trds Rev—Sept. 29, 1905. No. 72519 A.

Staybolts.

The Quality and Utility of Solid, Flexible and Hollow Staybolts, in Iron and Copper. John Livingstone. A discussion of this subject giving much information of value, and followed by a short general discussion. 13000 w. Pro N Y R R Club—Sept. 15, 1905. No. 72609.

Steel Rails.

Wear of Steel Rails on Bridges. Thomas Andrews. Read before the Ir. & Steel Inst. Report of investigations made of the fractured portion of a steel rail which had broken in main line service on a bridge, to determine, if possible, some of the causes of the breakage. Ills. 3500 w. Ir & Coal Trds Rev—Sept. 29, 1905. No. 72520 A.

Test-Pieces.

The Presence of Greenish-Colored Markings in the Fractured Surfaces of Test-Pieces. H. G. Howorth. Read before the Ir. & Steel Inst. Describes markings found in gun-steel test-pieces, the large proportion in which defects have been observed, and discusses their probable cause. 2800 w. Ir & Coal Trds Rev—Sept. 29, 1905. No. 72513 A.

Tool Steels.

High-Speed Steel in the Factory. O. M. Becker & Walter Brown. The third article gives working directions for making the tools, including hardening and tempering furnaces and details of manipulation. 3500 w. Engineering Magazine—Nov., 1905. No. 72792 B.

MEASUREMENT.

Friction.

The Laws of Sliding Friction (Sur les Lois du Frottement de Glissement). Paul Painlevé. A discussion of some of the ambiguous features in the accepted laws of the friction of rest and of sliding motion. 2000 w. Comptes Rendus—Aug. 21, 1905. No. 72716 D.

The Laws of Sliding Friction (Sur les Lois du Frottement de Glissement). Paul Painlevé. A further examination of the laws of Coulomb, showing their entire inadmissibility in certain cases. 2500 w. Comptes Rendus—Oct. 2, 1905. No. 72718 D.

Hydrometer.

How to Make a Hydrometer. Edward F. Chandler. Remarks concerning specific gravity, and illustrated description of the construction. 1100 w. Sci Am Sup—Oct. 21, 1905. No. 72595.

Inertia.

Moments of Inertia. Shows how they may be deduced by methods which require a merely elementary mathematical knowledge. 3500 w. Mech Engr—Sept. 30, 1905. No. 72457 A.

Refractometer.

An Improved Form of Refractometer. Illustrated description of an instrument, designed by G. F. Herbert Smith, in which the refractive power of a substance is determined by the method of total reflection. 1800 w. Min Jour—Oct. 14, 1905. No. 72671 A.

Strength.

Strength of Sections of Machinery. Frank B. Kleinhans. Presents a table which gives the moment in inch-pounds for various fiber stresses for circular sections, explaining its use. 700 w. Engr, U S A—Oct. 2, 1905. No. 72343 C.

Weighbridge.

The Avery Patent Combination Weighbridge. Illustrated description of a design which is so constructed and arranged that when a car is upon the weighbridge the load can be immediately ascertained upon either the one or the other axle or upon the two combined. 1000 w. Prac Engr—Sept. 29, 1905. No. 72456 A.

POWER AND TRANSMISSION.

Coal-Handling.

A Unique Coal-Handling Plant for an Electric Power Station. Illustrated description of the auxiliary coal storage and handling plant of the Syracuse, N. Y., lighting company. 1000 w. Eng News—Oct. 19, 1905. No. 72584.

Clutch.

A Novel Coil-Clutch Reversing Gear. Illustrates and describes an ingenious reversing gear placed on the English market, which is especially valuable with large machinery. 700 w. Sci Am Sup—Oct. 7, 1905. No. 72448.

Conveyors.

Belt Coal Conveyors. Francis H. Davies. An illustrated article describing early and recent types. 2400 w. Elec Rev, Lond—Oct. 13, 1905. No. 72678 A.

We supply copies of these articles. See page 477.

Cranes.

See Civil Engng., Waterways and Harbors.

Elevators.

Test of Electric Passenger Elevators in the Park Row Building, New York City. G. A. Balz, G. I. Brauch, and T. E. Landvoigt. Graduation Thesis. The object of the test was to determine the energy consumption of the electric elevators in kilowatt hours per car mile, and the average number of passengers carried. 4000 w. Stevens Ind—July, 1905. No. 72830 D.

The Hammetschwand Elevator on the Burgenstock (Der Hammetschwand Aufzug am Bürgenstock). An illustrated description of an elevator of 118 metres high, giving access to the cliffs on the bank of the lake of Lucerne. 1500 w. Schweiz Bauzeitung—Oct. 7, 1905. No. 72746 B.

Exhibition.

Prime Movers and Auxiliary Plant at Olympia. E. G. Beaumont. A review of the exhibits of this class shown at the electrical exhibition. 1800 w. Elec Engr, Lond—Sept. 29, 1905. Serial. 1st part. No. 72462 A.

Fans.

Fans. Charles L. Hubbard. Considers the centrifugal fan and the disk fan, explaining their theories, capacity, effect of temperature, &c. Ills. 3500 w. Mach, N Y—Oct. 1905. Serial. 1st part. No. 72373 C.

Gears.

The Worm Gear. John Edgar. A discussion of this form of gearing, referring to Mr. Halsey's article in the *American Machinist*. 1200 w. Mach, N Y—Oct., 1905. No. 72375 C.

Hoisting.

Hoisting Machinery at the Liége Exposition (Les Appareils de Levage à l'Exposition de Liége). L. Ramakers. Illustrations and details of electric traveling cranes exhibited in operation at Liége. 2000 w. 1 plate. Génie Civil—Sept. 23, 1905. No. 72707 D.

Prime Movers.

Prime Movers and Their Accessories in 1904. Editorial review of some features of Mr. Longridge's report for 1904 to the British Engine, Boiler, and Electrical Insurance Company, Ltd. 2000 w. Engng—Oct. 20, 1905. No. 72878 A.

Roller Bearings.

The Friction of Roller Bearings. C. H. Benjamin. Reports a series of experiments in which roller bearings were compared with plain cast-iron bearings and with babbitted bearings under similar conditions. 1000 w. Mach, N Y—Oct., 1905. No. 72374 C.

STEAM ENGINEERING.

Accidents.

Accidents Due to Faulty Piping and Incorrect Methods of Starting and Stopping Engines. Thomas Hall. Illustrated review of accidents due to faulty construction. 2400 w. Power—Nov., 1905. No. 72859 C.

Back Pressure.

Automatic Exhaust Relief Valve. Illustrates and describes the Anderson valve, which is claimed to have overcome all the difficulties met with in valves for maintaining a predetermined back pressure on steam engines. 1000 w. Engr, Lond—Oct. 20, 1905. No. 72889 A.

Boiler Firing.

An Aid to Systematic Firing of Marine Boilers. H. E. Lackey. Brief illustrated description of a device used on the "Galveston" to secure systematic firing. 700 w. Pro U S Nav Inst—Sept., 1905. No. 72599 D.

Boiler House.

Modern Boiler House Equipment. Franz Koester. An illustrated comparative review of modern European and American practice. 3000 w. St Ry Rev—Oct., 1905. No. 72636 C.

Boilers.

A New Type of Marine Fire-Tube Boiler. Illustrated description of the Scialpi boiler, with report of trials, and general information. 2500 w. Engr, Lond—Oct. 6, 1905. No. 72551 A.

Hydrostatic Tests of Locomotive Boilers. George Wagstaff. Discusses whether it is necessary or desirable to give a locomotive boiler the hydrostatic test, and if so, whether it should be greater than the allowed steam pressure. Also general discussion. 3300 w. Pro Cent Ry Club—Sept. 8, 1905. No. 72844 C.

Modification in Boiler Design Required by Liquid Fuel. George W. Melville. Excerpt from a paper presented at Milan. Showing that liquid fuel requires an ample combustion space. 2800 w. Eng & Min Jour—Sept. 30, 1905. No. 72393.

Robert Water-Tube Locomotive Boiler. M. F. Barbier, in *Le Genie Civil*. Illustrated description of a boiler of this type, which for more than a year has been in successful working in France. 1000 w. R R Gaz—Vol. XXXIX, No. 13. No. 72341.

Steam Boilers of the Past and Present. Egbert P. Watson. An historical review showing the evolution of modern types, with especial reference to boilers for marine service. 4500 w. Engineering Magazine—Nov., 1905. No. 72791 B.

We supply copies of these articles. See page 477.

Condensing Plant.

Condensing Plants for High Vacuums. The first of an illustrated series of articles describing the arrangement of the condensing apparatus in several kinds of turbines. 1800 w. Mach, N. Y—Oct., 1905. Serial. 1st part. No. 72380 C.

Draught.

Natural and Induced Draught. John W. Cobb. Explains briefly the mode of action of a chimney, and the production of forced draught, comparing their efficiency and things that should influence the choice of draught. 2500 w. Eng & Min Jour—Oct. 14, 1905. No. 72524.

Engines.

A Pacific Coast Engine. Illustrates and describes interesting features of a triple-expansion engine built to drive an alternating-current generator of 3,500 kw. capacity. 1200 w. Am Mach—Vol. 28, No. 41. No. 72493.

Possible Advantages of the Triple-Expansion Engine Over the Compound. E. F. Williams. Explains the merits and advantages of triple-expansion engines. 1800 w. Engr, U S A—Oct. 16, 1905. No. 72562 C.

Proposed Methods for Improving the Efficiency of the Steam Engine (Beschouwingen over de Middelen Aangewend ter Verhooging van het Rendement der Stoommachine). G. Brouwer. Discussing especially the advantages of compounding and the use of highly superheated steam. 4000 w. De Ingenieur—Sept. 30, 1905. No. 72782 D.

The Cockerill Rolling Mill Engine at the Liége Exhibition. Two-page plate and other illustrations, with brief description of this 10,000 h.p. reversing compound three-crank tandem steam-engine. 500 w. Engng—Sept. 22, 1905. No. 72313 A.

Expansion.

Conversion of Heat into Work by Adiabatic Expansion. A. M. Sevin. Gives table for finding the total energy obtained by expanding steam adiabatically, with explanation of its use. 2000 w. Power—Nov., 1905. No. 72860 C.

The Expansion of Wet Steam. Prof. Robert H. Smith. Explains a new law for the calculation of the work done during expansion. It is not exact, but has a very high order of accuracy, and is extremely simple and suited for practical calculation. 3300 w. Engr, Lond—Oct. 20, 1905. No. 72884 A.

Explosions.

Steam-Boiler Disasters (Uufälle aus dem Dampfkesselbetriebe). An abstract from a report of the Dortmund boiler inspection company, with illustrations and description of an explosion involving a collapsed flue. 1500 w. Glückauf—Oct. 7, 1905. No. 72738 D.

Flange Joints.

Packing Flange Joints. W. H. Wakeman. Suggestions helpful to the inexperienced. Ills. 1500 w. Power—Nov., 1905. No. 72861 C.

Load Diagram.

Load Diagram of a Mill Engine. F. H. Pember. Gives a diagram showing how the data derived from indicator cards, may be so arranged that they will present a graphic record of the all-day variations of load. 2000 w. Power—Nov., 1905. No. 72862 C.

Lubricators.

The Latest Makes of Lubricators, Their Operation and Maintenance. C. B. Conger. Abstract of a paper read before the Trav. Engrs. Assn. Describes changes introduced in late designs. 2000 w. Ry Age—Oct. 6, 1905. No. 72423.

Oil Fuel.

Equipment for Oil Fuel. George W. Melville. Excerpt from a paper presented to the Tenth Navigation Congress at Milan, 1905. Deals with strainers, the separation of water, oil pressure regulators, etc. 1200 w. Eng & Min Jour—Oct. 7, 1905. No. 72429.

Oil-Separators.

Oil-Separators at Shepherd's Bush Power-Station; C. L. Railway. Illustrated description of the improved Baker separators installed at the Central London Railway Co.'s power station. 900 w. Engng—Oct. 20, 1905. No. 72876 A.

Papin.

Papin's Direct-Acting Steam Pump (Papin's Direktwirkende Dampfpumpe). Conrad Matschoss. With a reproduction of Papin's early design of 1707, and a brief discussion of its historical position. 1000 w. Zeitschr d Ver Deutscher Ing—Oct. 14, 1905. No. 72733 D.

Sawmill Refuse.

The Value of Saw-Mill Refuse as a Fuel. O. B. Coldwell. Gives information concerning the lumber industry at Portland, Ore., and its by-products, describing the method of using the mixture of sawdust and cut-fuel as a steam producer, especially as related to the manufacture of electrical energy. 3000 w. Jour of Elec—Oct., 1905. No. 72576 C.

Smoke.

The Smoke Nuisance. R. P. King. Read before the Toledo convention of the League of Am. Munic. Considers the causes and remedies. 2000 w. Munic Jour & Engr—Oct., 1905. No. 72327 C.

Steam Economy.

Figuring the Steam Consumption from

the Indicator Diagram. S. H. Bunnell. Explains the method. 1200 w. Power—Nov., 1905. No. 72865 C.

Suggestions for Steam Economy. William McKay. Read before the Canadian Elec. Assn. Discusses some of the principles upon which economy in the use of steam depends. 2500 w. Sci Am Sup—Oct. 14, 1905. No. 72503.

Steam Lines.

Long Steam Line Construction. G. W. Barrager. Discusses the covering and the construction of the line. The size of pipe, the route and grading of the line, and other matters of importance are considered. Ills. 2500 w. Power—Nov., 1905. No. 72864 C.

Superheating.

Method of Computing the Amount of Superheating of Steam in the Cylinder of a Superheated Steam Engine. Prof. D. S. Jacobus. A detailed explanation of the method used by the writer. 700 w. Stevens Ind—July, 1905. No. 72829 D.

Turbines.

New Steam Turbine Power Plant of the Detroit Edison Company. Illustrated detailed description of this large new central generating plant and its equipment. 5500 w. Eng Rec—Oct. 7, 1905. No. 72482.

Steam Turbines (Ueber Dampfturbinen). Anton Kallus. A general review of the principles involved in the steam turbine, with descriptions of the various types. Two articles, 1 plate, 6000 w. Oesterr Zeitschr f Berg u Hüttenwesen—Sept. 16, 23, 1905. No. 72739 each D.

The Steam Turbines of the Union Machine Works of Essen (Die Dampfturbinen der Maschinenbau-Aktien-Gesellschaft Union in Essen d. d. Ruhr). Fritz Krull. General details of the Union turbine, as exhibited at Liége. 3000 w. Schweiz Bauzeitung—Sept. 30, 1905. No. 72745 B.

Steam Turbines (Stoomturbines). J. de Kuyser. A general description of the principal types now before the public, with illustrations. 5000 w. 2 plates. De Ingenieur—Sept. 30, 1905. No. 72781 D.

Valve-Gears.

The Operation of Valve Gears by Cams (Die Bewegungsverhältnisse von Stuergetrieben mit Unrunden Scheiben). W. Hartmann. A study of the kinematics of cam movements with especial reference to their applications in operating the valves of steam and gas engines. Two articles, 6000 w. Zeitschr d Ver Deutscher Ing—Sept. 30, Oct. 7, 1905. No. 72703 each D.

MISCELLANY.

Aeronautics.

The Dufaux Flying Machine. Illustrated description of a new apparatus able to rise in the air by the force of its propellers alone, driven by a gasoline motor. Recently tested at Paris. 1200 w. Sci Am—Oct. 21, 1905. No. 72591.

Breakdowns.

Breakdowns of Machinery in 1904. Interesting extracts from the report of Michael Longridge, which deals with mishaps in connection with engines, boilers, dynamos and motors. 1500 w. Elec Rev, Lond—Sept. 29, 1905. No. 72466 A.

Hotel Engineering.

The Engineer's Department of a Large Hotel. Storrs Ely Emmons. Gives some idea of the importance of this department and the need of system in its management. 1000 w. Mach, N. Y—Oct., 1905. No. 72378 C.

Projectiles.

The Action of Capped Armor-Piercing Shell. Eugen Kodar v. Thurnwerth. Capt. George Blakely. Translated from the German. Examines the reasons of the increased penetration of capped projectiles, on the basis of tests made with a variety of plates. Ills. 4300 w. Eng News—Oct. 5, 1905. No. 72400.

Woolwashing.

Woolwashing. Begins an illustrated description of apparatus designed for this work. 3000 w. Engr, Lond—Sept. 22, 1905. Serial. 1st part. No. 72319 A.

MINING AND METALLURGY

COAL AND COKE.

Arkansas.

Coal Mining in Arkansas. W. R. Crane. Describes and illustrates the deposits, methods of mining, preparation of the coal, etc. 3300 w. Eng & Min Jour—Oct. 28, 1905. No. 72851.

Briquettes.

The Schorr Briquette Press. Robert Schorr. Brief illustrated description of machine especially adapted for the manufacture of small briquettes for fuel. 600 w. Eng & Min Jour—Oct. 7, 1905. No. 72430.

We supply copies of these articles. See page 477.

Explosives.

Regulation of Explosives in Coal Mines. James Tonge. Remarks on the risks in the use of explosives, with a description of the nature of the tests at Woolwich. 3500 w. Ir & Coal Trds Rev—Oct. 13, 1905. No. 72694 A.

Haulage.

Animal Haulage in Coal Mines. Charles E. Bowron. Notes and data in regard to costs, derived from experience at mines in Alabama and Tennessee. 2600 w. Mines & Min—Oct., 1905. No. 72415 C.

The Mahanoy Coal Plane. Illustrates and describes the machinery used, and the method of hauling loaded railroad cars over the mountain from Mahanoy Valley. 1100 w. Mines & Min—Oct., 1905. No. 72414 C.

Illinois.

The Spring Valley Coal Company's Mines. Leo Gluck. An illustrated description of this coal field in Illinois, and the operation of the mines. 3500 w. Min Wld—Oct. 21, 1905. No. 72662.

Lignite.

The Lignite Deposits at Hrastovetz (Der Braunkohlenbergbau von Hrastovetz). Ivan Kavcic. An account of the deposits of brown coal in lower Styria, with data of chemical composition and calorific power. 1500 w. Oesterr Zeitschr f Berg u Hüttenwesen—Oct. 14, 1905. No. 72744 D.

Midlands.

The Search for Coal Beneath the Red Rocks of the Midland Counties. Wolcot Gibson. Gives important results obtained from the examination of several borings, with remarks of interest to mining engineers. 1500 w. Col Guard—Sept. 22, 1905. Serial. 1st part. No. 72311 A.

Peat.

Peat: Its Uses and Value. C. C. Schnatterbeck. Describes this product, and states the localities in the United States where deposits are found, describing the Peatkoal plant at New Rochelle, N. Y. Mentions some of its uses. 1200 w. Min Wld—Sept 30, 1905. No. 72330.

Peat Machine.

The Leavitt Peat Machine. Illustrated description of a machine designed to prepare crude peat by condensing for the evaporating treatment. 1500 w. Ir Age—Oct. 19, 1905. No. 72572.

Texas.

The Coal Fields of Texas. Heinrich Ries. Gives the locations of the different deposits, the quality of the coals as shown by analyses, and the production of the state. Ills. 1500 w. Mines & Min—Oct., 1905. No. 72416 C.

COPPER.

Alaska.

Central Copper Region, Alaska. Information from the report of Walter C. Mendenhall concerning this interesting region. 800 w. Min Wld—Sept. 30, 1905. No. 72331.

Mexico.

The La Dicha Mine, Guerrero, Mexico. Illustrated description of these copper mines, one of the most important American enterprises in Mexico. The ores are almost entirely pyritic sulphides, associated with chalcopyrite, and iron pyrite, and a valuable layer of black copper sulphide. 1200 w. Min Wld—Oct. 28, 1905. No. 72898.

Ores.

The Working of the Black Copper Ores at the Oker Works (Die Verarbeitung der Speisen und Speisigen Schwarzkupfer auf der Okerhütte). H. Huhn. A description of the working of the mixed copper-lead ores of the Rammelsberg district, in the Harz. 4000 w. Glückauf—Sept. 16, 1905. No. 72734 D.

Treatment of Copper Ore by the Electric Furnace. M. Vattier. Translated from the French. An account of experiments made in the metallurgy of copper where water power is available, by substituting electricity for coke, coal or charcoal. Describes the operations and methods used. 2200 w. Min & Sci Pr—Sept. 23, 1905. No. 72332.

Smelting.

The Bormettes-Method Lead and Copper Smelting. Alfredo Lotti. Illustrated description of this system, comparing it with other methods. 1600 w. Eng & Min Jour—Sept. 30, 1905. No. 72394.

Victoria.

The Walhalla Copper Mine (V.). William Baragwanath, Jr. Describes the location and deposits, development, etc. 3500 w. Aust Min Stand—Aug. 30, 1905. No. 72371 B.

GOLD AND SILVER.

Alaska.

Gold Mining in Southeastern Alaska (Der Goldbergbau in Südost Alaska). H. Haagen. Illustrating and describing the Alaska-Treadwell plant on Douglas Island. Two articles, 8000 w. Glückauf—Oct. 7, 14, 1905. No. 72737 each D.

Appalachians.

Gold Mining in the Southern Appalachians. Thomas T. Read. General notes concerning this field and its development. Map. 1000 w. Min Rept—Oct. 19, 1905. No. 72660.

We supply copies of these articles. See page 477.

Assay.

Notes on the Assay of Gold Bullion. T. Kirke Rose. A brief account of the principal changes in the assay of gold bullion which have been introduced at the Royal Mint, London, during the last three years. 1800 w. Jour Chem, Met & Min Soc of S Africa—Aug., 1905. No. 72675 E.

Australia.

Australian Gold and Gold Mining. John Plummer. Information of interest concerning the production, development, and present condition of the industry. 1000 w. Min Wld—Oct. 14, 1905. No. 72555.

Black Sands.

Investigation of Black Sands by the United States Geological Survey. Gives results from the assaying of 195 specimens for gold and platinum, and an account of field work and concentration experiments. 1400 w. Min Rept—Oct. 5, 1905. No. 72437.

Broken Hill.

Broken Hill Proprietary Co. A review of the 20 years' record of this mine, especially the half-yearly statement for the period ending May 31, 1905. Silver-lead mining. 2200 w. Aust Min Stand—Aug. 23, 1905. No. 72369 B.

Central America.

Darien Gold Mines. An illustrated description of the Espiritu Santo mine and its development under hard conditions. 1500 w. Min & Sci Pr—Sept. 30, 1905. No. 72439.

Comstock Lode.

Structure and Genesis of the Comstock Lode. John A. Reid. (Abstract.) Describes the formation, showing evidence of successive deposition in the Virginia City portion of the lode, and giving information of interest. 2500 w. Min & Sci Pr—Oct. 7, 1905. No. 72559.

Cripple Creek.

Drainage of the Cripple Creek District. An epitome of the recommendations of D. W. Brunton relative to the construction of a drainage tunnel. Map. 500 w. Min Rept—Oct. 19, 1905. No. 72661.

Cyanide Mill.

The Tonopah Milling Co.'s Mill. S. A. Worcester. Outline drawings and description of a mill to be located at Goldfield Junction. 1000 w. Eng & Min Jour—Oct. 14, 1905. No. 72526.

Dredging.

Application of Electric Power to Gold Dredging. J. F. Dostal. Read at meeting of the Colorado Elec. Lgt., Power & Ry. Assn. Describes the object and method of dredging and the schemes for regaining the gold. Also describes the dredgers and the electrical equipment of one of them. 2200 w. Min & Sci Pr—Oct. 7, 1905. No. 72560.

The Career of the Gold Dredge in New South Wales. David K. Blair. Abstract of a paper in *Trans. of the Australasian Min. Engrs.* Gives a brief history of the career of the gold dredge from its introduction, March, 1899, up to the present time. 2200 w. Eng & Min Jour—Oct. 28, 1905. No. 72850.

Egypt.

The Gold Production of Egypt. Reviews what is known of the early history of gold mining in Egypt. Map. 3000 w. Min Jour—Oct. 14, 1905. No. 72672 A.

Fluxing Ores.

A District Which Will Supply Fluxing Ores for the Tonopah (Nev.) Mines. W. J. Stoneham. Information concerning the Lone Mountain Mining district, and the large bodies of fluxing ore found there. 1200 w. Min Wld—Oct. 7, 1905. No. 72438.

Nevada.

Ores of Goldfield, Nevada. J. E. Spurr. Abstract from "Contributions to Economic Geology" for 1904. Considers the geological situation, the nature and origin of the ore deposits, and conditions in the region. 2700 w. Mines & Min—Oct., 1905. No. 72419 C.

Nova Scotia.

In Nova Scotia. T. A. Rickard. Gives a map of the gold region, and information concerning conditions in the mining region in the present article. 1200 w. Min & Sci Pr—Oct. 21, 1905. Serial. 1st part. No. 72890.

South America.

Gold Mining in South America. J. H. Curle. From *The Economist.* Information concerning this industry, the output, the drawbacks and the future development. 1200 w. Min Rept—Oct. 12, 1905. No. 72557.

South Dakota.

Common Sense Mining. W. H. Storms. On the management of low-grade mines, discussing especially the gold mines of South Dakota. 2200 w. Min & Sci Pr—Oct. 21, 1905. No. 72891.

IRON AND STEEL.

Blast Furnaces.

Notes on American Blast-Furnace Practice (Betrachtungen über den Amerikanischen Hochofenbetrieb). Bernhard Osann. A comparison between American and German furnaces and methods. 3500 w. Stahl u Eisen—Oct. 15, 1905. No. 72728 D.

Practical Results in the Operation of the Blast Furnaces of Ekaterinoslav, Rus-

sia (Résultats Pratiques de la Marche des Haut Fourneaux d'Ekaterinoslaw). M. Pierronne. Data and results of the action of furnaces of various sizes and forms, with sketches and discussion. 10,000 w. Revue de Métallurgie—Sept., 1904. No. 72785 G.

Carbon.

The Two Forms of Carbon in Iron Temper-Carbon and Graphite (Beitrage zur Kenntuis der Zwei Kohlenstofformen im Eisen, Temperkohle und Graphit). F. Wüst and C. Geiger. A study of the influence of heat treatment upon the combination of carbon in iron. Serial. Part I. 3000 w. Stahl u Eisen—Oct. 1, 1905. No. 72724 D.

Carbon Steels.

The Thermal Transformations of Carbon Steels. John Oliver Arnold and Andrew McWilliam. Read before the Iron & Steel Inst. Gives the composition of the three steels selected for the research work described, the methods, etc. Ills. 8500 w. Engng—Sept. 29, 1905. No. 72477 A.

Electric Smelting.

See Electrical Engineering, Electro-Chemistry.

Furnace Gases.

Blast-Furnace Gases. John Herman, in *Western Chemist and Metallurgist.* Gives analyses made of gases in several places, discussing the fuel and blast. 1200 w. Eng & Min Jour—Oct. 21, 1905. No. 72643.

Cleansing Blast-Furnace Gas. Axel Sahlin. An illustrated article showing the advantages and importance of cleaning the gas, and the methods of cleaning; describing apparatus used. 4500 w. Cassier's Mag—Oct., 1905. No. 72623 B.

The Bian Apparatus for Purifying and Cooling Blast-Furnace Gases (Reinigungs und Kühlapparat für Hochofengase System Bian). Fritz Krull. The gas is passed through disks of wire netting partly immersed in water. 1200 w. Oesterr Zeitschr f Berg u Hüttenwesen—Oct. 14, 1905. No. 72743 D.

Handling.

A Manipulator for Steel Bars. Douglas Upton. Read before the Iron and Steel Inst. Illustrates and describes appliances for the mechanical handling of sectional material during the process of manufacture. 700 w. Engng—Sept. 29, 1905. No. 72478 A.

Iron Deposits.

Iron Resources of the World. R. Anspach. Translated from the *Zeit. für angewandte Chemie.* Information from the report of Prof. A. E. Törnebohm to the Swedish Parliament. 2800 w. Eng & Min Jour—Oct. 7, 1905. No. 72432.

Italy.

The Iron Industry of Italy (Die Eisenindustrie Italiens). Carl Brisker. With tabular statements of the output of the various districts and of the exports and imports of iron ore and pig iron. 5000 w. Stahl u Eisen—Oct. 1, 1905. No. 72720 D.

Nickel Steel.

The Reversible and Irreversible Transformations of Nickel Steel. L. Dumas. Abstract of a paper read before the Ir. & Steel Inst. Discusses the remarkable properties of nickel steels which have not undergone the irreversible transformation, and the effects produced by adding nickel to steel. 1500 w. Ir & Coal Trds Rev—Sept. 29, 1905. No. 72521 A.

Pig-Irons.

Note on the Occurrence of Copper, Cobalt, and Nickel in American Pig-Irons. E. D. Campbell. Read before the Ir. & Steel Inst. Gives analyses of samples, mostly from charcoal or coke blast furnaces in the United States, to determine the extent to which copper, cobalt, and nickel occurs in pig-iron made from ore found in the different districts. 800 w. Ir & Coal Trds Rev—Sept. 29, 1905. No. 72518 A.

Rolling Mills.

Electric Driving of Reversing Rolling Mills (Der Elektrische Antrieb von Reversierwalzwerken). Karl Ilgner. A discussion of the advantages of electric driving for rolling mills, with data and results of tests upon a number of installations. Two articles, 7500 w. Zeitschr d Oesterr Ing u Arch Ver—Sept. 22, 29, 1905. No. 72714 each D.

Electric Driving of Rolling Mills (Elektrischer Antrieb von Walzwerken). A. Bayer. A mathematical examination of the conditions of rolling-mill work, showing the proportions of fly-wheel necessary to overcome the maximum resistance. 3500 w. Oesterr Zeitschr f Berg u Hüttenwesen—Sept. 23, 1905. No. 72740 D.

Segregation.

Segregation in Steel Ingots. B. Talbot. Read before the Ir. & Steel Inst. Gives tabulated results obtained from parallel tests made on ingots from the same heat, with and without the addition of a small amount of aluminum to the ingot, discussing the effects. 2800 w. Ir & Coal Trds Rev—Sept. 29, 1905. No. 72514 A.

Sheffield.

Sheffield Past and Present. An interesting review of the rise, progress, and existing conditions of the steel industry. 10500 w. Ir & Coal Trds Rev—Sept. 29, 1905. No. 72512 A.

We supply copies of these articles. See page 477.

Slags.

Recent Investigations upon Blast-Furnace Slag (Neue Untersuchungen über Hochofenschlacke). Dr. Hermann Passow. Experiments upon the granulation of slag for the manufacture of cement. 1500 w. Stahl u Eisen—Oct. 1, 1905. No. 72723 D.

The Melting Point of Slags and Other Members of the Series SiO_2—Al_2O_3—CaO. Clifford Richardson. Calls attention to the fact that many of the melting points and conclusions drawn from them are erroneous. 1000 w. Ir & Steel Mag—Oct., 1905. No. 72600 D.

Steel.

Overheated Steel. Arthur Windsor Richards, and John Edward Stead. Reviews opinions of investigators of overheated steel, and gives further researches of the writers, emphasizing the fact that poor steel cannot be made into good steel by any kind of heat treatment, but that good steels heated short of incipient disintegration can be completely restored. 4500 w. Engr, Lond—Sept. 29, 1905. No. 72481 A.

Steel Industry.

The German Steel Makers Association and Its Commercial Influence (Der Deutsche Stahlwerks-Berband und Seine Bedeutung für unser Wirtschaftsleben). Oscar Simmersbach. A review of the German steel industry with comparative diagrams and tables, and an examination of the influence of the combination upon the trade. 9000 w. Glasers Annalen—Oct. 1, 1905. No. 72719 D.

Steel Process.

The Chemical Action in the Combined Bessemer-Open-Hearth Process at Witkowitz (Chemische Vorgänge beim Kombinierten Bessemer-Martin Verfahren zu Witkowitz). C. Canaris. Giving the composition of the charges, and the chemical and mechanical properties of the product. 2000 w. Stahl u Eisen—Oct. 1, 1905. No. 72722 D.

The Use of Blast-Furnace Gas for the Reduction of Iron Ore in Modern Open-Hearth Steel Processes (Hochofengase zum Reduzieren von Eisenerz für die Neueren Herdofenstahlprozesse). Oskar Simmersbach. Giving the chemical equations and thermal reactions involved in the reduction of various ores by carbon monoxide. 1200 w. Stahl u Eisen—Oct. 15, 1905. No. 72730 D.

Steels.

The Influence of Nickel and Carbon on Iron. G. B. Waterhouse. Read before the Ir. & Steel Inst. A report of research work, considering a series of steels of constant nickel with varying carbon percentages. 1500 w. Ir & Coal Trds Rev—Sept. 29, 1905. No. 72516 A.

Vanadium.

The Use of Vanadium in Metallurgy. Léon Guillet. Read before the Ir. & Steel Inst. Gives a summary of the author's researches and the conclusions. 4500 w. Ir & Coal Trds Rev—Sept. 29, 1905. No. 72517 A.

See Also Mechanical Engineering, Machine works and Foundries.

See Also Mechanical Engineering, Materials.

MINING.

Ankylostomiasis.

Ankylostomiasis: A Critical Study. The present number is largely introductory; stating the serious nature of the disease, and reviewing the history of the Westphalian epidemic. 2000 w. Col Guard—Oct. 20, 1905. Serial. 1st part. No. 72873 A.

Check Sampling.

Check Sampling the Great Fingall Mine, Western Australia. Charles M. Rolker. Describes the methods, giving results. 3800 w. Min Jour—Sept. 30, 1905. No. 72471 A.

Desulphurization.

The Carmichael-Bradford Process. Illustrated description of this process, which has been put into practical use at Broken Hill, N. S. W. 2000 w. Eng & Min Jour—Oct. 28, 1905. No. 72853.

Explosives.

The Ignition of Explosives (Ueber Zündung von Sprengstoffen). C. E. Bichel. A paper before the Mining Congress at Liége discussing the non ignition of high explosives by impact, with tabulated results of experiments upon a variety of materials. 3500 w. Glückauf—Sept. 23, 1905. No. 72736 D.

Hoist.

Electric Hoist at the Tiremande Colliery. Emile Guarini. Illustrates and describes a novel arrangement in which the hoist is placed at top of head-frame. 1200 w. Mines & Min—Oct., 1905. No. 72417 C.

Mine Buildings.

Tile vs. Brick for Mine Buildings. William L. Affelder. Statements in regard to cost and adaptability of tile for purposes for which brick is commonly used. 1200 w. Mines & Min—Oct., 1905. No. 72421 C.

Olympia Exhibition.

Electrical Exhibition at Olympia. Begins a description of such exhibits as are of interest to the mining engineer. 3000 w. Col Guard—Oct. 6, 1905. Serial, 1st part. No. 72543 A.

We supply copies of these articles. See page 477.

Ore Treatment.

The Treatment of Tin-Wolfram-Copper Ores at the Clitters United Mines. F. Dietzsch. Read before the Inst. of Min. & Met. An illustrated account of the reopening of these old Cornish mines and the modern methods introduced. 4000 w. Min Jour—Oct. 21, 1905. Serial. 1st part. No. 72872 A.

Prospecting.

What Veins to Choose. Prof. Arthur Lakes. Discusses indications likely to be found when prospecting in a region of crystalline rocks. 1800 w. Mines and Min—Oct., 1905. No. 72420 C.

Pyrite.

Pyrite Mining in St. Lawrence County, New York. Robert B. Brinsmade. Gives the location of these mines and describes the development of the three producing mines. 1800 w. Eng & Min Jour—Oct. 28, 1905. No. 72848.

Quarrying.

Marble Quarrying at Gouveneur, N. Y. Robert B. Brinsmade. An illustrated description of the marble and methods of quarrying. 2000 w. Eng & Min Jour—Oct. 21, 1905. No. 72645.

Rand.

Electric Power Distribution for the Rand. Robert Hammond. Read before the British Assn., at Johannesburg. A discussion of the problem of supplying electrical energy for the mines, the cost, etc. Also short discussion. 6800 w. Elect'n. Lond—Sept. 29, 1905. No. 72469 A.

Rock Drilling.

Notes on the Construction and Practical Operation of Rock-Drilling Machines. E. M. Weston. Notes on practical work at machine drilling, giving information of value. 10000 w. Jour Chem, Met & Min Soc of S Africa—Aug., 1905. No. 72676 E.

Safety Appliances.

Invention to Guard Against Deadly Gases. Illustrated description of an apparatus for rescue work in firedamp. Also statistics concerning explosions in Wales. 2000 w. U S Cons Repts—Sept., 1905. No. 72901 D.

Saving Life in Mines. Illustrates and describes an apparatus invented to guard against deadly gases in mines, devised by Professors Bemberger and Böck, of Vienna. 900 w. Min Rept—Oct. 12, 1905. No. 72558.

Sampling.

Hand Sampling in Small Stamp Mills. A. W. Warwick. Discusses the effects of careless sampling methods, with suggestions for accurate sampling. 1400 w. Min & Sci Pr—Oct. 21, 1905. No. 72892.

Shaft Boring.

New Shaft-Boring Apparatus. Illustrates and describes an interesting invention shown at the Liége Exhibition. The inventors are Messrs. Frieh and Nöllenburg. 1200 w. Col Guard—Oct. 20, 1905. No. 72874 A.

Sketching.

Mining Sketches. Prof. Arthur Lakes. Describes the making of geological and topographical drawings of a large district, and perspective underground sketching. 2300 w. Ills. Mines & Min—Oct., 1905. No. 72418 C.

Sliming.

A Discussion of Sliming Tables. J. C. Bailar. Read before the West. Assn. of Tech. Chem. & Met. Also a discussion of Hand Sampling in Small Stamp Mills, by A. W. Warwick, and a general discussion. 3500 w. Min Wld—Oct. 21, 1905. No. 72663.

Stamp Mills.

How to Cure a Rocking Mortar in a Stamp Mill. Paul J. Johnson. Discusses the cause of rocking mortars, and explains the writer's method of remedying the trouble. Ills. 900 w. Min Rept—Oct. 26, 1905. No. 72894.

Supplies.

The Card System for Mine Supplies. W. M. Jeffrey. Read before the L. Sup. Min. Inst. Outlines a card system of accounting, stating its advantages. 4000 w. Eng & Min Jour—Oct. 28, 1905. No. 72855.

Winding.

Wire Ropes for Winding Purposes. R. Hunter. Read before the Mine Mgrs.' Assn., Queensland. Reviews briefly the history of wire ropes, the class used for winding purposes, laws relating to winding-ropes, testing, &c. 2500 w. Queens Gov Min Jour—Aug. 15, 1905. Serial. 1st part. No. 72372 B.

MISCELLANY.

Aluminum.

Aluminum and Bauxite. Charles C. Schnatterbeck. Extract from Mineral Resources of U. S. Geol. Surv. Information concerning the aluminum industry, the prices, chief alloys, uses, &c. Also the output of bauxite and its value. 2600 w. Min Wld—Oct. 14, 1905. No. 72556.

Assaying.

The Assaying of Zinc Ores as Carried On in the Joplin District, Missouri. E. W. Buskett. Describes the laboratory equipment and methods commonly used. 2500 w. Mines & Min—Oct., 1905. No. 72413 C.

We supply copies of these articles. See page 477.

Diamonds.

Australia's Largest Diamond. John Plummer. Information concerning the discovery, with description of the gem, and discussion of its source, &c. 1200 w. Min Wld—Oct. 21, 1905. No. 72664.

Fertilizer.

A Valuable Bat Cave in New Mexico. F. W. Brady. Remarkable caves containing extensive deposits of dry guano are illustrated and described. 1000 w. Mines & Min—Oct., 1905. No. 72412 C.

Lead.

Lead-Smelting at Monteponi, Sardinia. Erminio Ferraris. Trans. from *Oest. Zeit. f. Berg- und Hüttenwesen.* Illustrated description of the smelting works and methods. 1500 w. Eng & Min Jour—Oct. 28, 1905. No. 72854.

Lime Roasting of Galena. W. Maynard Hutchings. Discusses the Huntington-Heberlein treatment and other systems, and reports experimental investigations. 2700 w. Eng & Min Jour—Oct. 21, 1905. No. 72644.

The Lead Ores of Southwestern Missouri. C. V. Petraeus and W. George Waring. Describes these deposits, their treatment, value, &c., reviewing the development of the industry. 1200 w. Eng & Min Jour—Oct. 21, 1905. No. 72642.

The Huntington-Heberlein Process from the Hygienic Standpoint. A. Biernbaum. Translated from the *Zeitschrift für das Berg-, Hütten und Salinenwesen.* Discusses the improvement in danger from lead-poisoning. 2500 w. Eng & Min Jour—Oct. 14, 1905. No. 72523.

Metals.

Crystalline and Amorphous States of Metals. Editorial review of the presidential address of Mr. G. T. Beilby, before the Chemical Section of the British Association at Johannesburg. On the researches in regard to the hard and soft states of metals. 2500 w. Engng—Sept. 22, 1905. No. 72316 A.

Molybdenite.

Molybdenite in British Columbia. Horace F. Evans. Describes its occurrence and the area. But little development work has been done. 1800 w. Min Wld—Oct. 21, 1905. No. 72665.

Monazite.

Monazite in the Beach-Sands of Queensland. B. Dunstan. Describes the deposits and the mineral, giving localities where it has been found. 1100 w. N Z Mines Rec—Aug. 16, 1905. No. 72866 B.

Petroleum.

Petroleum Boring at Wietze, Hannover (Die Erdölgewinnung bei Wietze, Prov. Hannover). W. Kaemmerer. Illustrated description of derricks and boring apparatus at Wietze-Steinförde where 41,000 metric tons of petroleum were produced in 1903. 3000 w. Zeitschr d Ver Deutscher Ing—Sept. 23, 1905. No. 72702 D.

The Baker Oil-Fields in 1904. A. Beeby Thompson. Information from recently published statistics concerning production, cost, &c. 3500 w. Engng—Oct. 20, 1905. No. 72875 A.

Selenium.

Calorimetric Estimation of Selenium. J. E. Clennell. Gives a method for the rapid approximate estimation of small quantities of selenium in ores, bullion, smelting-room products, zinc-gold precipitates, cyanide solutions, &c. 900 w. Eng & Min Jour—Oct. 28, 1905. No. 72852.

Statistics.

The Mineral Industries of the United States. E. C. Eckel. A carefully classified review of the mineral products of the United States, showing their relative importance and growth. 3500 w. Engineering Magazine—Nov., 1905. No. 72789 B.

Sulphuric Acid.

Sulphuric Acid Manufacture. F. Luety. Abstract translation of a paper in *Zeit. für angewandte Chemie.* Reviews the principal modern improvements in the sulphuric-acid chamber-process, and deals more in detail with a method due to H. H. Niedenfuehr. Ills. 2500 w. Eng & Min Jour—Oct. 7, 1905. No. 72431.

Tap Jackets.

The Evolution of Tap Jackets and Spouts. Hiram W. Hixon. Describes the tap jackets used in lead smelting; and the furnace spouts used in copper smelting. 1200 w. Eng & Min Jour—Oct. 14, 1905. No. 72523.

Tin.

Tin Mining in Tasmania. Hartwell Conder. Reviews briefly the past history, and describes present conditions. 1800 w. Min Jour—Sept. 30, 1905. No. 72472 A.

Troostite.

The Nature of Troostite. Dr. Carl Benedicks. Abstract of a paper read before the Ir. & Steel Inst. Examines arguments of other investigators, and gives the writer's conclusions. 1200 w. Ir & Coal Trds Rev—Sept. 29, 1905. No. 72515 A.

Vanadium.

Applications of Vanadium in Metallurgy (Emplois du Vanadium en Métallurgie). Léon Guillet. An account of the sources of vanadium, the preparation of ferro-vanadium and the properties of vanadium alloy-steels. Serial. Part I. 1800 w. Génie Civil—Oct. 14, 1905. No. 72773 D.

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Zinc.

The Electric Smelting of Zinc Ores. Frederick T. Snyder, in Trans. of the Can. Min. Inst. Describes the present method of smelting on a lead basis ores containing gold and silver, comparing with a gas producer and gas engine dynamo system, and a system when the water-wheel replaces the gas producer and gas engine. 2500 w. Can Min Rev—Oct., 1905. No. 72561 B.

The Properties of Sheet Zinc (Ueber die Eigenschaften von Zinkblech). Dr. Oswald Meyer. Data and results of tests upon plates of zinc for tension, flexure and elasticity. Two articles. 1 plate. 5000 w. Oesterrr Zeitschr f Berg u Hüttenwesen—Oct. 7, 14, 1905. No. 72742 each D.

RAILWAY ENGINEERING

CONDUCTING TRANSPORTATION.

Car Handling.

Per Diem. W. G. Hunter. Short paper introducing a general discussion of this subject. 4500 w. Pro Iowa Ry Club—Sept. 11, 1905. No. 72608 C.

Hospital Car.

Hospital Car, Southern Pacific Company. Illustrated detailed description of a fine car equipped for the service of a well appointed hospital. 1500 w. Ry & Engng Rev—Oct. 28, 1905. No. 72895.

Organization.

The Organization of Railway Shop Forces. H. T. Bentley. Discussion of the requisites necessary to obtain the best results. General discussion follows. 10000 w. Pro W Ry Club—Sept. 19, 1905. No. 72610 C.

Payment.

Cash versus Checks in Paying Railway Employes. Gives arguments that have been suggested against and in favor of each of the methods of payment. 4000 w. Ry Age—Sept. 29, 1905. No. 72338.

Train Services.

Summer Train Services in 1905—British and French. Charles Rous-Marten. A review of the improvement in fast service and a comparison to England's disadvantage. 3000 w. Engr, Lond—Oct. 6, 1905. No. 72553 A.

MOTIVE POWER AND EQUIPMENT.

Brakes.

High Speed Brakes. Robert Burgess. Explains the action of high-speed brakes, the apparatus and the effects. General discussion. Ills. 8000 w. S & S-W Ry Club—Aug. 17, 1905. No. 72522 E.

Brake Trials.

Special Fifty-Car Train Demonstrations at West Seneca, N. Y. A report of the tests made August 23, at West Seneca, N. Y. 1600 w. Ry & Loc Engng—Oct., 1905. No. 72428 C.

Cars.

Buffalo & Susquehanna Dump Car. Illustration and brief description of a side dump coke car of large capacity and minimum weight. 400 w. Ry & Loc Engng—Oct., 1905. No. 72426 C.

Self-Discharging Single-Hopper Wagon; Prussian State Railways. Illustrations, with brief description. 300 w. Engng—Oct. 13, 1905. No. 72685 A.

Steel Wagon Construction in the United States. Notes on the general methods of a modern American steel car shop which tend to rapidity of manufacture. 1800 w. Engr, Lond—Oct. 13, 1905. No. 72690 A.

The Evolution of the Coal Car. C. H. Caruthers. An interesting review, with illustrations. 2200 w. R R Gaz—Vol. XXXIX., No. 16. No. 72651.

Electrification.

An Unprecedented Railway Situation. Frank J. Sprague. Analyzes the conditions which will be brought about by an attempt to utilize a. c.—d. c. locomotives in the present d. c. zone of the New York Central & Hudson River R. R. Co., outlining the situation and discussing both electrical and operating features. 5000 w. St Ry Jour—Oct. 21, 1905. No. 72659 C.

Electric Traction for Railroad Service. J. A. Shaw. Read before the Can. Ry. Club. Discusses the advantages of electricity over steam, the systems at present available for heavy electric traction, and the merits of each. 3500 w. Eng Rec—Oct. 14, 1905. No. 72567.

Electrification of Railways. H. W. Wilson. Read before the Liverpool Engng. Soc. Outlines various methods of electrical operation of railways and considers their adaptability to varying conditions. 5000 w. Mech Engr—Sept. 30, 1905. Serial. 1st part. No. 72458 A.

Niagara Electric Power for Steam Railways of Western New York. Mentions new fields for large amounts of electric power and reviews what has been done and is being done in the line of

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generating stations in the vicinity of Niagara Falls. Ills. 6000 w. Ry & Engng Rev—Oct. 14, 1905. No. 72554.

Locomotive Building.

Locomotive Building in New South Wales. Editorial review of the industrial history that has led to the giving of the contract for sixty locomotives within the State of New South Wales. 1700 w. Engng—Sept. 22, 1905. No. 72317 A.

Locomotives.

Articulated Locomotives. Charles S. Lake. Illustrates and describes several types of articulated locomotives, which are well suited for working round curves of small radius and on steep gradients. 2800 w. Mech Engr—Oct. 14, 1905. No. 72673 A.

A Study of American Locomotives. M. J. Oudet. Translated from *Revue Mécanique*. Discusses the design of American locomotives, and some of the reasons why the prices of manufacture are lower than in other countries. 1400 w. R R Gaz—Vol. XXXIX., No. 16. No. 72649.

Balanced Compound Locomotive, P. R. R. Illustrations and general dimensions of a new Cole compound passenger engine. 600 w. Ry & Engng Rev—Oct. 7, 1905. No. 72440.

Compound Articulated Locomotive for the Northern Railway of France. H. W. Hanbury. Illustrated detailed description of an engine exhibited at Liége, which is attracting much attention because of its novel design. It is to be used for coal traffic which is exceedingly heavy. 2200 w. Engng—Oct. 6, 1905. No. 72547 A.

Freight Locomotive 4-6-0 Type. Illustration and dimensions of locomotives to which Walschaert valve gear has been applied. A ten-wheel type for the C., R. I., & P. Ry. 250 w. Am Engr & R R Jour—Oct., 1905. No. 72367 C.

French 6-2-2-6 Compound Freight Locomotive. Illustrated description of a new design for hauling heavy coal trains over variable grades. 900 w. Ry & Engng Rev—Oct. 7, 1905. No. 72443.

Heavy Passenger Locomotive for Lackawanna. Illustrates and describes what is believed to be the heaviest passenger locomotive ever built in the 10-wheel type. 500 w. Ry Age—Oct. 27, 1905. No. 72847.

Lackawanna Locomotive with Schenectady Superheater. Illustrated description of the eight-wheeled (4-4-0) locomotive recently built and fitted with the Cole superheater. 900 w. R R Gaz—Oct. 15, 1905. No. 72510.

Locomotives at the St. Louis Exposition (Les Locomotives à l'Exposition de Saint Louis). A general review of the engines exhibited, with illustrations and a comparative table. 4000 w. Rev Gen d Chem de Fer—Sept., 1905. No. 72726 G.

Locomotives for the Panama R. R. Illustrates one of the engines of the 2-6-4 type, 24 of which are now ready. 500 w. Ry & Engng Rev—Oct. 28, 1905. No. 72896.

Passenger Belpaire Engines, Midland Railway. Illustration and particulars of a new express locomotive. 300 w. Engr, Lond—Sept. 29, 1905. No. 72480 A.

Prairie Type Engine for the Chicago, Burlington & Quincy. Illustrates and describes the interesting features of these engines, giving general dimensions. 900 w. R R Gaz—Vol. XXXIX., No. 16. No. 72647.

Six-Coupled Passenger Locomotive, London and North-Western Railway. 2-page plate and drawings, with principal dimensions and notes. 400 w. Engr, Lond—Oct. 6, 1905. No. 72552 A.

Sixteen-Wheel Double Tank Locomotive for the Northern Railway of France. Illustrated detailed description of an interesting engine shown at the recent exposition at Liége, Belgium. 1500 w. R R Gaz—Vol. XXXIX., No. 14. No. 72406.

The Distribution of Weight in Locomotives. Jas. Horsfall. Begins with a study of the four-wheeled engine, using the graphic method. 1500 w. Prac Engr—Oct. 6, 1905. Serial. 1st part. No. 72536 A.

Motor Cars.

Gasoline Motor Car No. 2, U. P. R. R. Illustrated description of this car and its improvements over car No. 1. Its strength is one of the most interesting features. 1200 w. Ry & Engng Rev—Oct. 7, 1905. No. 72442.

Motor Cars for Railway Service (Motorwagen im Eisenbahnbetriebe). A. Heller. A fully illustrated account of various types of self-propelled cars for local railway service, using both steam and gasoline. Serial. Part I. 5000 w. Zeitschr d Ver Deutscher Ing—Sept. 23, 1905. No. 72700 D.

Steam Motor Cars on the Taff Vale Ry., England. Drawings and description. 600 w. Eng News—Oct. 5, 1905. No. 72402.

Rolling-Stock.

The Earning Power of British Rolling Stock from 1894 to 1903. W. Pollard Digby. Gives tables showing the rolling stock, the railway earnings, the average earnings per locomotive, and other statistics of interest. 2500 w. Engr, Lond—Sept. 22, 1905. No. 72320 A.

Traction.

The Computation of the Loads for the

We supply copies of these articles. See page 477.

Locomotives of the Danish State Railways (Determination des Charges à Appliques aux Locomotives des Chemins de Fer de l'Etat Danois). Formulas and curves showing the hauling capacity of the engines at various speeds. 1200 w. Génie Civil—Oct. 7, 1905. No. 72713 D.

Train Lighting.

Dissolved Acetylene. Discusses the manufacture of this gas, as given in a recent paper by Herr Kuchel, and the process of using it, especially in regard to its application for the illumination of trains. 3300 w. Engr, Lond—Oct. 20, 1905. No. 72887 A.

Signal Lamps.

The Design, Construction, Efficiency and Maintenance of Signal Lamps. Report of committee of Railway Signal Assn., at Niagara Falls meeting. Discussion and report of tests, maintenance, conclusions, &c. 6500 w. Eng News—Oct. 19, 1905. No. 72586.

Valve Gears.

New American Valve Gears for Locomotives. Illustrates and describes the Alfree valve gear, and the Young locomotive valve gear. 1200 w. Engr, Lond—Oct. 20, 1905. No. 72886 A.

The Construction of the Link of the Heusinger-Walschaert Valve Gear (Die Konstruktion des Schleifbogens der Heusinger Steuerung). W. Hanff. Giving equations and diagrams for laying out slide-valve gears of the Walschaert type. 800 w. Zeitschr d Ver Deutscher Ing—Oct. 7, 1905. No. 72706 D.

The Stephenson and Walschaert Valve Gears. James Kennedy. Describes the Walschaert valve gear, stating its apparent advantages. Ills. 1800 w. Ry & Loc Engng—Oct., 1905. No. 72427 C.

Valve Tests.

Tests of the Westinghouse Improved Quick-Service Triple Valves. A report of tests made at West Seneca, N. Y., showing the ability of modern brake apparatus and friction draft gear to meet the present severe service conditions of train operation. 1700 w. R R Gaz—Vol. XXXIX., No. 16. No. 72648.

Ventilation.

Car Ventilation. Ross Taylor. Brief paper followed by discussion, in which Round House ventilation is also discussed. 5000 w. Pro St Louis Ry Club—Sept. 8, 1905. No. 72342.

NEW PROJECTS.

Austria.

The Tauern Railroad from Schwarzach to Bad Gastein. Emil S. Fischer. Illustrated description of this recently opened road which passes through some of the highest and most picturesque parts of the Eastern Alps. 1800 w. Ry & Engng Rev—Oct. 21, 1905. No. 72666.

Extension.

Recent Work on the Indiana Harbor R. R. Begins an illustrated detailed description of the construction of an extension from Lake Michigan to Danville, Ill. 3500 w. Eng Rec—Sept. 30, 1905. Serial. 1st part. No. 72359.

Florida Keys.

The Florida East Coast Extension to Key West. An illustrated account of this projected extension, now under construction, which will afford greatly improved facilities for communication between Cuba and the mainland. 1000 w. R R Gaz—Vol. XXXIX., No. 14. No. 72407.

PERMANENT WAY AND BUILDINGS

Coal Storage.

Lehigh Valley Coal Storage Plant. Illustrations, with brief description, of the plant at Wyoming, N. Y., 20 miles from Buffalo, for storing anthracite coal. 600 w. Ry Age—Sept. 29, 1905. No. 72339.

Interlocking.

The Cost of Stopping Trains, Compared with the Cost of Maintenance, Operation and Inspection of Interlocking Plants. J. A. Peabody. Read at the convention of the Ry. Sig. Assn. Gives statistics showing the costs as derived from experiments, and tables showing the saving to be effected by interlocking plants. 1500 w. Eng News—Oct. 12, 1905. No. 72498.

Power Plant.

Modern Railroad Terminal Power Plant. Illustrates and describes the fine generating station of the New York Central & Hudson River Railroad at Weehawken, N. J. 3500 w. Am Elect'n—Oct., 1905. No. 72381.

Reconstruction.

Rebuilding the Cairo Division of the Big Four. Describes the condition of this portion of the line, giving an illustrated account of the reconstruction in progress to prepare it for the heavy traffic due to development of immense coal fields. 2500 w. R R Gaz—Vol. XXXIX, No. 17. No. 72824.

Shops.

Blacksmith Shop. Illustrates and describes this part of the plant of the Angus shops, Montreal. 1200 w. Am Engr & R R Jour—Oct., 1905. No. 72368 C.

South Louisville Shops, Louisville and Nashville R. R. An illustrated description of the large new repair and manufacturing plant recently put into operation. 5500 w. Ry & Engng Rev—Oct. 7, 1905. Serial. 1st part. No. 72441.

We supply copies of these articles. See page 477.

Sierra Leone.

A West-African Railway: The Sierra Leone Line. J. Hartley Knight. Describing the construction of a British pioneer railway connecting the interior with the West Coast and aiding in developing commerce. 2000 w. Engineering Magazine—Nov., 1905. No. 72787 B.

Signaling.

Normal Danger vs. Normal Clear. C. H. Platt. States the important reasons published for favoring the normal clear system, discussing each in detail and favoring the normal danger system. 1500 w. R R Gaz—Vol. XXXIX., No. 15. No. 72508.

Report of Committee No. 13 on Rubber-Covered Wire. Report presented to the convention of the Railway Signal Association. Suggestions as to requirements and tests, with reasons. 2800 w. Elec Rev, N Y—Oct. 28, 1905. No. 72819.

Signal Lenses. A. G. Wilson. Discusses the lenses now applied to railroad lamps, the tests that should be made, &c. 1400 w. R R Gaz—Vol. XXXIX., No. 14. No. 72408.

Terminals.

New Freight Terminal at Cincinnati, of the Cincinnati, New Orleans and Texas Pacific. Illustrates and describes this new terminal, giving a map showing its location. 1500 w. R R Gaz—Vol. XXXIX., No. 13. No. 72340.

Terminal Improvements of the New York Central & Hudson River in New York. G. R. Wadsworth. Illustrated detailed description of the extensive alterations and important changes in progress. 2800 w. R R Gaz—Vol. XXXIX., No. 16. No. 72650.

Ties.

New Concrete Ties and Steel Ties. Brief illustrated descriptions of two forms of reinforced concrete ties now being tested, and a new design of steel tie which is now in service under exceptionally heavy traffic. 900 w. Eng News—Oct. 5, 1905. No. 72401.

Water Tanks.

Protection of Water Tanks from Action of Frost. From a Committee report to the Assn. of Ry. Supts. of Bridges & Buildings. Gives extracts from a circular of inquiry, and summary of information received. Ills. 3000 w. Ry & Engng Rev—Oct. 28, 1905. No. 72897.

TRAFFIC.

Freight.

Following Up Time, Fast or Carded Freight. P. D. Satchwell. Describes a carefully worked out system, known as the "Best by Test.' 1700 w. Ry Age—Oct. 20, 1905. No. 72646.

Freight Seals.

Seals for Freight Cars. An explanation of the plan of sealing freight cars and its value in tracing any theft of freight. 1200 w. Sci Am Sup—Oct. 7, 1905. No. 72450.

New South Wales.

New South Wales Railways. Editorial review of the report of the Commissioners for the year ending in June, 1905, which shows an increase in nearly every department of traffic. 2000 w. Engng—Oct. 20, 1905. No. 72880 A.

MISCELLANY.

British Railways.

Notes on British Railways. Angus Sinclair. An explanation of how circumstances influenced the growth of railways. 1400 w. Ry & Loc Engng—Oct., 1905. No. 72425 C.

STREET AND ELECTRIC RAILWAYS

Accounting.

Accounting with Four Departments. H. M. Beardsley. Read before the St. Ry. Accountants' Assn. Describes the methods in use at Elmira, N. Y. 3000 w. St Ry Rev—Oct., 1905. No. 72639 C.

Interurban Ticket Accounting. J. H. Pardee. Read before the St. Ry. Acc. Assn. Describes the system in use on the Rochester & Eastern Rapid Railway. 1000 w. St Ry Rev—Oct., 1905. No. 72640 C.

Belfast.

Belfast City Tramways. Illustrated detailed description of an extensive electric system of the latest designs. 11700 w. Tram & Ry Wld—Oct. 12, 1905. No. 72696 B.

Berlin-Zossen.

The Berlin-Zossen Tests of 1902. Abstracts of the results of the 1902 tests of train resistance and braking at high speed. 4800 w. St Ry Jour—Oct. 28, 1905. No. 72902 C.

We supply copies of these articles. See page 477.

Brake.

An Emergency Track Brake. F. F. Bodler. Read before the Am. Ry., Mech., & Elec. Assn. Illustrates and describes this brake which is used on almost all of the cars in San Francisco. 1000 w. St Ry Jour—Sept. 30, 1905. No. 72354 C.

Chicago.

The Street Railways of Chicago. Part of an address by Mayor Dunne before the League of Am. Munic. explaining his scheme for securing early municipalization. 2500 w. Munic Jour & Engr—Oct., 1905. No. 72326 C.

Cleveland.

New Operating Features in Cleveland. Illustrates and describes a test car, derrick car, stone crusher, concrete conveyor, new track construction, &c. 1500 w. St Ry Jour—Oct. 14, 1905. No. 72529 C.

Collision.

The Hall Road Collision. A review of the report of Lieut.-Col. Druitt, who was appointed to conduct the inquiry into the cause of the collision which occurred on July 27, on the electric railway. 1700 w. Engr, Lond—Oct. 20, 1905. No. 72885 A.

Compressed-Air.

An Industrial Compressed Air Railway. C. B. Hodges. Illustrated description of the compressed-air system of transportation at the new reduction works of the Anaconda Copper Mining Company, at Anaconda, Montana. 3000 w. Cassier's Mag—Oct., 1905. No. 72625 B.

Construction.

Overhead Construction. Robert N. Tweedy. Discussing some details in connection with poles, wiring, &c., and referring to paper by Mr. Sayers. 2000 w. Elec Rev, Lond—Oct. 20, 1905. Serial. 1st part. No. 72869 A.

Controller.

The Series-Parallel Railway Controller. W. A. Pearson. Read before the Am. Ry., Mech., & Elec. Assn. Reviews the development of the series-parallel controller for street-car service, and describes the methods of making the series to parallel change. 2500 w. St Ry Jour —Sept. 30, 1905. No. 72351 C.

Distribution.

The Power Distributing System of the Boston Elevated Railway Company. C. H. Hile. Read at convention of the Am. Ry., Mech., & Elec. Assn. Describes this system of separate power plants, with their interconnected power distributing systems, giving facts, results and experiences as representative of such engineering practices. 4000 w. St Ry Jour—Sept. 30, 1905. No. 72348 C.

Electric Locomotives.

Metropolitan Railway Electric Locomotives. Brief illustrated description of the 150-ton electrical locomotives being supplied. 600 w. Engr, Lond—Sept. 22, 1905. No. 72323 A.

Electric System.

The New Haven's Electric Railway System. Reviews the history of the upbuilding of this system. Map. 1200 w. R R Gaz—Vol. XXXIX., No. 17. No. 72823.

Electric Traction.

Discussion on "Heavy Electric Freight Traction," at Asheville, N. C. 4000 w. Am Inst of Elec Engrs—Sept., 1905. No. 72839 D.

Progress in Electric Traction (Fortschritte auf dem Gebiete der Elektrischen Zugförderung). Friedrich Eichberg. Describing especially recent three-phase and single-phase interurban lines in Germany and Austria. 2500 w. Zeitschr d Ver Deutscher Ing—Sept. 23, 1905. No. 72701 D.

Electrification.

See Railway Engineering, Motive Power.

Equipment.

Electric Railway Equipment. W. B. Potter. Read before the Am. Ry., Mech., & Elec. Assn. Considers a few of the features relating to the development of the past few years—steam turbines, motors, controlling, car wiring, fuses, &c. 3500 w. St Ry Jour—Sept. 30, 1905. No. 72358 C.

Gas Power.

The Application of Gas Power to Electric Railway Service. J. R. Bibbins. Read before the Am. Ry., Mech., & Elec. Assn. Aims to show the adaptability of the gas engine and producer to street railway service, giving results that have already been attained in driving electrical machinery. Ills. 5000 w. St Ry Jour—Sept. 30, 1905. No. 72356 C.

Hastings.

Hastings Electric Tramways. Illustrated description of a system of interest because of the extremely steep grades and sharp curves. 3000 w. Elect'n, Lond—Oct. 13, 1905. No. 72680 A.

The Tramway System of Hastings. Full illustrated description of a system having features of interest. 5000 w. Tram & Ry Wld—Oct. 12, 1905. No. 72697 B.

Instruction.

The Policy of More Liberal Instruction for Motormen. Edward Taylor. A discussion of the system of instruction which

will best fit the motorman for his duties and responsibilities. 5500 w. St Ry Rev —Oct., 1905. No. 72637 C.

Insulation.

The Insulation of Overhead Lines. W. B. Esson. Discusses the materials used, the design of insulators, illustrating and describing examples of recent practice. 2200 w. Engr, Lond—Oct. 6, 1905. No. 72549 A.

Interurban.

Interurban Fare Collections. Irwin Fullerton. Read before the St. Ry. Acc. Assn. Describes the system in effect on the Detroit United Ry. system. 1500 w. St Ry Rev—Oct., 1905. No. 72641 C.

The Toledo & Indiana Railway. Illustrated description of a recently opened extension from Wauseon to Bryan. 5500 w. St Ry Jour—Oct. 21, 1905. No. 72658 C.

London Underground.

The Electrification of the London Underground Railway (Die Einführung des Elektrischen Betriebes bei den Vereinigten Londoner Stadtbahnen). K. Meyer. A general description of the conversion work, with details of the substations, cars and roadbed. 3000 w. Zeitschr d Ver Deutscher Ing—Oct. 7, 1905. No. 72705 D.

Multiple Unit.

Multiple Unit Systems of Train Control. Hugh Hazelton. Read at convention of Am. Ry., Mech., & Elec. Assn. Describes the two types of multiple-control apparatus now in use, illustrating details, and showing the merits of the system for interurban and street railway lines. 3000 w. St Ry Jour—Sept. 30, 1905. No. 72350 C.

New York Subway.

The New York Rapid Transit Railway. The present article explains the conditions on Manhattan Island and begins an illustrated detailed description of the construction of the rapid transit subway. 2000 w. Engr, Lond—Oct. 13, 1905. Serial. 1st part. No. 72691 A.

Power House.

The Missouri-River Power-House of the Metropolitan Street Railway Company, Kansas City, Missouri. F. G. Cudworth. Illustrated detailed description of the 40,000 K. W. station of the Metropolitan Street Railway Co. 8000 w. Eng News—Oct. 19, 1905. No. 72585.

Power Plant.

The Power Plant of the Boston & Worcester Street Railway. Howard S. Knowlton. Illustrated detailed description. 2500 w. Eng Rec—Oct. 14, 1905. No. 72570.

Rail-Joints.

The Treatment of Rail-Joints. A series of papers assembled and edited by Fred G. Simmons, describing the practice of the electric street and interurban railways of America. Ills. Presented before the Am. Ry., Mech., & Elec. Assn. 10500 w. St Ry Jour—Sept. 30, 1905. No. 72352 C.

Single Phase.

Electric Traction by Single Phase Alternating Currents (Traction Electrique par Courant Alternatif Monophase). M. Auvert. Describing a system in which the alternating current is converted into a continuous one by a rectifier carried on the locomotive. 7000 w. 1 plate. Rev Gen de Chem de Fer—Oct., 1905. No. 72727 G.

The Single-Phase Railway. M. P. Randolph. Read at the Portland exposition congress. Describes the particular features of the alternating-current series motor, also details of the car equipment, and other matters relating principally to interurban service. 4000 w. Jour of Elec —Oct., 1905. No. 72575 C.

"The Single-Phase Railway" and "Electric Railway Equipment." Abstract of a paper by W. B. Potter, and abstract of a discussion of both Mr. Scott's and Mr. Potter's papers. 4500 w. Elec Rev, N. Y —Oct. 28, 1905. No. 72820.

The Single-Phase Railway System. Charles F. Scott. Read before the Am. Ry., Mech., & Elec. Assn. Presents the important features of this system, and the results of the work accomplished in developing apparatus to meet the demands in electric traction. 4000 w. St Ry Jour —Sept. 30, 1905. No. 72357 C.

Three-Phase.

Discussion on "Three-Phase Traction," at Asheville, N. C. 7500 w. Am Inst of Elec Engrs—Sept., 1905. No. 72838 D.

Toronto.

The Toronto Street Railway Agreement. Francis S. Spence. Read before the Toledo convention of the League of Am. Munic. Gives the history and the details of the agreement under which the company operates, explaining the situation. 3000 w. Munic Jour & Engr—Oct., 1905. No. 72325 C.

Trackless.

Trackless Trolleys (Gleislose Bahnen). W. Butz. Illustrating recent progress in electric traction on common roads with overhead trolleys for the supply of current. Illustrations are given of omnibus equipment and of trains of trailers for merchandise. 3500 w. Eisenbahntech Zeitschr—Sept. 6, 1905. No. 72774 D.

We supply copies of these articles. See page 477.

EXPLANATORY NOTE—THE ENGINEERING INDEX.

We hold ourselves ready to supply—usually by return of post—the full text of every article indexed in the preceding pages, *in the original language*, together with all accompanying illustrations; and our charge in each case is regulated by the cost of a single copy of the journal in which the article is published. The price of each article is indicated by the letter following the number. When no letter appears, the price of the article is 20 cts. The letter A, B or C denotes a price of 40 cts.; D, of 60 cts.; E, of 80 cts.; F, of $1.00; G, of $1.20; H, of $1.60. Certain journals, however, make large extra charges for back numbers. In such cases we may have to increase proportionately the normal charge given in the Index. In ordering, care should be taken to *give the number* of the article desired, not the title alone.

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CARD INDEX.—These pages are issued separately from the Magazine, printed on one side of the paper only, and in this form they meet the exact requirements of those who desire to clip the items for card-index purposes. Thus printed they are supplied to regular subscribers of THE ENGINEERING MAGAZINE at 10 cts. per month, or $1.00 a year; to non-subscribers, 25 cts. per month, or $3.00 a year.

THE PUBLICATIONS REGULARLY REVIEWED AND INDEXED.

The titles and addresses of the journals regularly reviewed are given here in full, but only abbreviated titles are used in the Index. In the list below, *w* indicates a weekly publication, *b-w*, a bi-weekly, *s-w*, a semi-weekly, *m*, a monthly, *b-m*, a bi-monthly, *t-m*, a tri-monthly, *qr*, a quarterly, *s-q*, semi-quarterly, etc. Other abbreviations used in the index are: Ill—Illustrated; W—Words; Anon—Anonymous.

American Architect. *w.* New York.
American Electrician. *m.* New York.
Am. Engineer and R. R. Journal. *m.* New York.
American Jl. of Science. *m.* New Haven, U.S.A.
American Machinist. *w.* New York.
Annales des Ponts et Chaussées. *m.* Paris.
Ann. d Soc. d Ing. e d Arch. Ital. *w.* Rome.
Architect. *w.* London.
Architectural Record. *m.* New York.
Architectural Review. *s-q.* Boston.
Architect's and Builder's Magazine. *m.* New York.
Australian Mining Standard. *w.* Melbourne.
Autocar. *w.* Coventry, England.
Automobile. *m.* New York.
Automobile Magazine. *m.* New York.
Automotor Journal. *w.* London.
Beton und Eisen. *qr.* Vienna.
Boiler Maker. *m.* New York.
Brit. Columbia Mining Rec. *m.* Victoria, B. C.
Builder. *w.* London.
Bull. Am. Iron and Steel Asso. *w.* Phila., U. S. A.
Bulletin de la Société d'Encouragement. *m.* Paris.
Bulletin of Dept. of Labor. *b-m.* Washington.
Bull. Soc. Int. d Electriciens. *m.* Paris.
Bulletin of the Univ. of Wis., Madison, U. S. A.
Bulletin Univ. of Kansas. *b-m.* Lawrence.
Bull. Int. Railway Congress. *m.* Brussels.
California Jour. of Tech. *m.* Berkeley, Cal.
Canadian Architect. *m.* Toronto.
Canadian Electrical News. *m.* Toronto.
Canadian Engineer. *m.* Toronto and Montreal.
Canadian Mining Review. *m.* Montreal.
Cassier's Magazine. *m.* New York and London.
Cement. *b-m.* New York.
Cement Age. *m.* New York.
Central Station. *m.* New York.

Chem. Met. Soc. of S. Africa. *m.* Johannesburg.
Colliery Guardian. *w.* London.
Compressed Air. *m.* New York.
Comptes Rendus de l'Acad.des Sciences. *w.* Paris.
Consular Reports. *m.* Washington.
Deutsche Bauzeitung. *b-w.* Berlin.
Domestic Engineering. *m.* Chicago.
Eisenbahntechnische Zeitschrift. *b-m.* Berlin.
Electrical Engineer. *w.* London.
Electrical Magazine. *m.* London.
Electrical Review. *m.* London.
Electrical Review. *w.* New York.
Electrical World and Engineer. *w.* New York.
Electric Journal. *m.* Pittsburg, Pa.
Electrician. *w.* London.
Electricien. *w.* Paris.
Electricity. *w.* London.
Electricity. *w.* New York.
Electrochemical and Met. Industry. *m.* New York.
Elektrochemische Zeitschrift. *m.* Berlin.
Elektrotechnische Zeitschrift. *w.* Berlin.
Elettricita. *w.* Milan.
Engineer. *w.* London.
Engineer. *s-m.* Chicago.
Engineering. *w.* London.
Engineering and Mining Journal. *w.* New York.
Engineering Magazine. *m.* New York & London.
Engineering News. *w.* New York.
Engineering Record. *w.* New York.
Engineering Review. *m.* London.
Eng. Soc. of Western Penna. *m.* Pittsburg, U.S.A.
Far Eastern Review. *m.* Manila, P. I.
Fire and Water. *w.* New York.
Foundry. *m.* Cleveland, U. S. A.
Génie Civil. *w.* Paris.
Gesundheits-Ingenieur. *s-m.* München.
Giorn. Dei Lav. Pubb. e. d. Str. Ferr. *w.* Rome.
Glaser's Ann. f Gewerbe & Bauwesen. *s-m.* Berlin.
Ice and Refrigeration. *m.* New York.
Ingenieria. *b-m.* Buenos Ayres.
Ingenieur. *w.* Hague.
Insurance Engineering. *m.* New York.
Iron Age. *w.* New York.
Iron and Coal Trades Review. *w.* London.
Iron & Steel Magazine. *m.* Cambridge, Mass.
Iron and Steel Trades Journal. *w.* London.
Iron Trade Review. *w.* Cleveland, U. S. A.
Jour. Am. Foundrymen's Assoc. *m.* New York.
Journal Asso. Eng. Societies. *m.* Philadelphia.
Journal of Electricity. *m.* San Francisco.
Journal Franklin Institute. *m.* Philadelphia.
Journal of Gas Lighting. *w.* London.
Journal Royal Inst. of Brit. Arch. *s-qr.* London.
Jour. Roy. United Service Inst. *m.* London.
Journal of Sanitary Institute. *qr.* London.
Jour. of South African Assn. of Engineers. *m.* Johannesburg, S. A.
Journal of the Society of Arts. *w.* London.
Journal of U. S. Artillery *b-m.* Fort Monroe, U.S.A.
Jour. W. of Scot. Iron & Steel Inst. *m.* Glasgow.
Journal Western Soc. of Eng. *b-m.* Chicago.
Journal of Worcester Poly. Inst., Worcester, U.S.A.
Locomotive. *m.* Hartford, U. S. A.
Machinery. *m.* New York.
Madrid Cientifico. *t-m.* Madrid.
Marine Engineering. *m.* New York.
Marine Review. *w.* Cleveland, U. S. A.
Mem. de la Soc. des Ing. Civils de France. *m.* Paris.
Métallurgie. *w.* Paris.
Minero Mexicano. *w.* City of Mexico.
Mines and Minerals. *m.* Scranton, U. S. A.
Mining and Sci Press. *w.* San Francisco.
Mining Journal. *w.* London.
Mining Magazine. *m.* New York.
Mining Reporter. *w.* Denver, U. S. A.
Mittheilungen des Vereines für die Förderung des Local und Strassenbahnwesens. *m.* Vienna.
Municipal Engineering. *m.* Indianapolis, U. S. A.
Municipal Journal and Engineer. *m.* New York.
Nature. *w.* London.
Nautical Gazette. *w.* New York.
New Zealand Mines Record. *m.* Wellington.
Oest. Wochenschr. f. d. Oeff. Baudienst. *w.* Vienna.
Oest. Zeitschr. Berg- & Hüttenwesen. *w.* Vienna.
Plumber and Decorator. *m.* London.
Popular Science Monthly. *m.* New York.
Power. *m.* New York.
Practical Engineer. *w.* London.
Pro. Am. Soc. Civil Engineers. *m.* New York.
Pro. Canadian Soc. Civ. Engrs. *m.* Montreal.
Proceedings Engineers' Club. *qr.* Philadelphia.
Pro. Pacific Coast Rwy. Club. *m.* San Francisco.
Pro. St. Louis R'way Club. *m.* St. Louis, U. S. A.
Pro. U. S. Naval Inst. *qr.* Annapolis, Md.
Public Works. *qr.* London.
Quarry. *m.* London.
Queensland Gov. Mining Jour. *m.* Brisbane, Australia.
Railroad Gazette. *w.* New York.
Railway Age. *w.* Chicago.
Railway & Engineering Review. *w.* Chicago
Railway and Loc. Engng. *m.* New York.
Review of Reviews. *m.* London & New York.
Revista d Obras. Pub. *w.* Madrid.
Revista Tech. Ind. *m.* Barcelona.
Revue de Mécanique. *m.* Paris.
Revue Gen. des Chemins de Fer. *m.* Paris.
Revue Gen. des Sciences. *w.* Paris.
Revue Industrielle. *w.* Paris.
Revue Technique. *b-m.* Paris.
Revue Universelle des Mines. *m.* Liége.
Rivista Gen. d Ferrovie. *w.* Florence.
Rivista Marittima. *m.* Rome.
Schiffbau. *s-m.* Berlin.
Schweizerische Bauzeitung. *w.* Zürich.
Scientific American. *w.* New York.
Scientific Am. Supplement. *w.* New York.
Sibley Jour. of Mech. Engng. *m.* Ithaca, N. Y.
Stahl und Eisen. *s-m.* Düsseldorf.
Stevens' Institute Indicator. *qr.* Hoboken, U.S.A.
Street Railway Journal. *w.* New York.
Street Railway Review. *m.* Chicago.
Tijds v h Kljk. Inst. v Ing. *qr.* Hague.
Traction and Transmission. *m.* London.
Tramway & Railway World. *m.* London.
Trans. Am. Ins. Electrical Eng. *m.* New York.
Trans. Am. Ins. of Mining Eng. New York.
Trans. Am. Soc. Mech. Engineers. New York.
Trans. Inst. of Engrs. & Shipbuilders in Scotland, Glasgow.
Transport. *w.* London.
World's Work. *m.* New York.
Yacht. *w.* Paris.
Zeitschr. d. Mitteleurop. Motorwagen Ver. *s-m.* Berlin.
Zeitschr. d. Oest. Ing. u. Arch. Ver. *w.* Vienna.
Zeitschr. d. Ver. Deutscher Ing. *w.* Berlin.
Zeitschrift für Elektrochcemie. *w.* Halle a S.
Zeitschr. f. Elektrotechnik. *w.* Vienna.

CURRENT RECORD OF NEW BOOKS

NOTE—Our readers may order through us any book here mentioned, remitting the publisher's price as given in each notice. Checks, Drafts, and Post Office Orders, home and foreign, should be made payable to THE ENGINEERING MAGAZINE.

Hydraulics.

Hydraulic Tables. By Gardner S. Williams and Allen Hazen. Size, 9 in. by 6 in.; pp. iv, 75. Price, $1.50. New York: John Wiley & Sons. London: Chapman & Hall, Limited.

This modest little volume is a valuable addition to one of the most important departments of engineering. For a long time the study of the flow of water in pipes and channels has been hampered by the incubus of an idea that a formula devised nearly a century ago by Chézy was correct. This formula stated that the velocity of flow was dependent upon the square root of the hydraulic slope times the hydraulic radius, a constant coefficient being also involved. The trouble with the formula was that the constant was not constant, but altogether erratic and unreliable. Kutter, the Swiss engineer, tried to improve matters, and devised a formula for computing the constant coefficient, but the trouble with his formula was that it involved another coefficient, called the coefficient of roughness, which had to be guessed at, according to the ideas of the engineer as to the nature of the channel or pipe under consideration. The result was that a quantity of elaborate computations had to be made, using data which were dependent altogether upon the judgment of the man who was doing the work. The whole performance suggests the old story of the manner in which a certain shop sold its scrap iron, that is, by having everybody in the office look at the scrap heap and guess at its weight, and then averaging the guesses.

In late years some American engineers, among whom may be mentioned Fenkell and Tutton, became possessed of a sufficient spirit of heresy to suggest that perhaps Chézy was wrong, and that the formula was not in proper shape, and the result was a change in the value of the exponents, so that the formula has been modified in various ways and forms deduced in which the constant coefficient is really constant and not subject to change according to the opinion of the man making the computations. Messrs. Williams and Hazen have examined the subject in the light of these declarations of independence, and selected exponents and coefficients which agree very closely with the results of tests, and have tabulated the corresponding values for the flow of water in pipes, sewers, and other channels, the figures being computed by a modification of the slide rule made to correspond with their formula. The tables give the flow of water in pipes of various materials, and include slopes required to produce certain velocities, and the book will be found most useful to hydraulic engineers.

Power Plants.

Commercial Economy in Steam and other Thermal Power Plants. By Robert H. Smith. Diagrams by H. Malcolm Hodson. Size, 10 in. by 6 in.; pp. xxiv, 291. Price, 24 shillings. London: Archibald Constable & Co., Limited. Philadelphia: J. B. Lippincott Co.

The appearance of this book is evidence of the increasing attention which is being paid to the fact that the engineer must also be a business man. As Professor Smith says, the main endeavor of the book is to persuade the mechanical engineer to advance from the primitive view that engineering science can guide him only in the physical construction and the physical dynamics of his machinery, to the much more complete idea that scientific method must also be applied to his reckonings of cost and of value produced. The only true economy is an all-round economy, and mechanical pride in the difficult attainment of purely physical excellence must leave unshaken our readiness to sacrifice mechanical perfection to low cost in such degree as yields the best economic ratio of resulting value to working expenditure.

Professor Smith has produced a book which should be studied by every engineer who aims to design steam engines which shall have the highest economy, not of

steam, nor of fuel, but of money. To this end he discusses the relation of commercial economy to physical efficiency, capital charges, and working costs, taking up first the subjects of production, profit, and economy in general, deriving what he calls the "economy-coefficient"; this consisting of product divided by cost and time. Having reduced the commercial elements involved to their mathematical relations, these are applied to the special subject of the true economical production of power from heat, the whole subject being given a strict mathematical treatment.

Believing that the engineer should not take refuge in approximations of dubious accuracy when correct computations are possible, the author has given the results of his studies mainly in curves, plotted upon such a large scale as to render the readings of sufficient precision for practical use, thus removing any excuse as to the impracticability of the mathematical treatment on the score of difficulty.

We have advocated for a long time the study of methods of cost-keeping and commercial accounting as related to the manufacture of the products of the machine shop, and we are only too glad to call attention to the able manner in which Professor Smith has developed the stuuy of the scientific application of similar methods to the manufacture of power. The book is a most illuminating one, and should find a place in the library of every thoughtful engineer.

Space Telegraphy.

Wireless Telegraphy; Its History, Theory, and Practice. By A. Frederick Collins. Size, 9 in. by 6 in.; pp. xii, 300. Price, $3.00. New York: McGraw Publishing Company.

Mr. Collins, who is well known by his previous publications in the technical press upon the subject of telegraphic and telephonic communication through space by means of electrical waves, has given in this volume a very readable review of the present state of the art. Preceding the discussion of the practical side of the subject by chapters upon the ether, upon wave motion, and upon electrical discharges and oscillations, the author proceeds to examine the devices by which electrical waves may be made and received, followed by descriptions of the apparatus employed in the practical use of the theoretical principles. The book is especially valuable as a record of what has been done, gathering into convenient form the work of many investigators, and thus forming an account of the work already performed in a department of applied science which is undoubtedly in its early stages, and from which great developments may be expected.

BOOKS RECEIVED.

Hydraulic Power Engineering. By G. Croydon Marks. Price, 9 shillings ($3.50). London: Crosby Lockwood & Son. New York: D. Van Nostrand Co.

Theory of Structures and Strength of Materials. By Henry T. Bovey. Fourth Edition. Price, $7.50. New York: John Wiley & Sons. London: Chapman & Hall, Ltd.

Cements, Limes, and Plasters. By Edwin C. Eckel. Price, $6.00. New York: John Wiley & Sons. London: Chapman & Hall, Ltd.

Radio-Activity. By E. Rutherford. Price, 12 s. 6d. ($4.00). Cambridge: The University Press. New York: The Macmillan Company.

Soils and Fertilizers. By Harry Snyder. Price, $1.50. Easton, Pa.: The Chemical Publishing Company.

Electricians' Handy Book. By T. O'Conor Sloane. Price, $3.50. New York: The Norman W. Henley Company.

The Design and Construction of Metallic Bridges. By William H. Bur and Myron S. Falk. Price, $5.00. New York: John Wiley & Sons. London: Chapman & Hall, Ltd.

Advanced Mechanical Drawing. By Alpha Pierce Jamison. Price, $2.00. New York: John Wiley & Sons. London: Chapman & Hall, Ltd.

Principles of Electrical Power. By A. H. Bate. Price, 4s. 6d. ($1.75). London: E. & F. Spon, Ltd. New York: Spon & Chamberlain.

Physics. By Charles Riborg Mann and George Ransome Twiss. Price, $1.25. Chicago: Scott, Foresman & Co.

Machine Shop Tools and Methods. By W. S. Leonard. Price, $4.00. New York: John Wiley & Sons. London: Chapman & Hall, Ltd.

IMPROVED MACHINERY

New Processes and Appliances

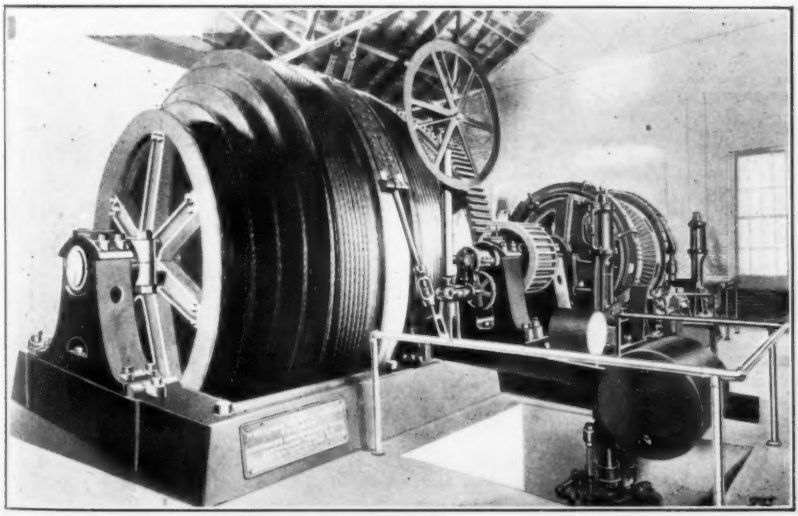
The matter here published is not paid for, nor can it be classed as advertising. But as the information is necessarily obtained from those who offer the appliances for sale, it is proper to say that the manufacturers, rather than ourselves, are responsible for the statements made.

A Novel Water Hoist.

THE question of unwatering a mine always is a serious problem to the mine management, especially so when the water is highly impregnated with acids. When the amount becomes excessive the means to be employed for disposing of it taxes the ingenuity of all concerned to the uttermost.

In the anthracite regions there are mines in which for every ton of coal raised, as much as fourteen tons of water must be pumped. Nowhere, probably, have a greater variety of pumps and lifting devices been tried, and the most satisfactory type, up to the present, for handling large quantities of water at comparatively low heads, has proved to be large boilers operated by steam engines. These, however, lack the mechanical regularity inherent in a pump, and it remained for the Delaware, Lackawanna & Western R. R. Co. and its electrical engineer, H. M. Warren, to develop a water-hoisting equipment which would preserve all the valuable points of the steam hoist and at the same time operate automatically. The carrying out of the mechanical details of the hoist and its automatic devices were confided to the Wellman-Seaver-Morgan Company, Cleveland, Ohio. Most of the electrical controlling devices were furnished by the Electric Controller & Supply Company, Cleveland, Ohio.

An accompanying illustration shows a front view of the hoist. As will be noticed the general arrangement consists of a motor driving a pair of bevel wheels through a single bevel pinion. The bevel wheels run loose on a shaft and are fitted with Webster, Camp & Lane friction clutches. The operating mechanisms for the clutches are so designed that only one clutch can be thrown in at a time, but both clutches can



be out at the same time. Throwing in one clutch runs the drum in one direction; throwing in the other clutch reverses the motion of the drum. To the shaft on which the bevel wheels run there is keyed a pinion meshing with main gear on the drum shaft. The drums are of the cylindro-conical type, 10′ at the small diameter and 16′ at the large diameter. At a hoisting speed of 550′ per minute the drum makes about 15 revolutions per minute. There is one main brake located between the drums. All of the clutches and brakes are operated by auxiliary air cylinders fitted with oil cushion cylinders, the compressed air being furnished by a motor driven air compressor and the necessary tanks located near to the hoist. The hoist is controlled by a mechanical device consisting mainly of a drum rotated by means of a friction drive from the motor through a sprocket chain. The drum shaft transmits its motion to a secondary shaft fitted with variable speed, which in turn operates a secondary stop. The main hoisting drum shaft operates a traveling nut which is so located with respect to the controller drum that at either end of its travel it releases a stop and allows the controller drum to make a quarter turn; this movement, through suitable electrical connections, operates the solenoids on the clutch valve, releasing the clutch and the solenoid on the brake valve setting the brake, the further movement of the controlling drum being arrested by the secondary stop. This stop is released by the variable speed shaft and its connections, which has been given a predetermined time movement corresponding to the interval for emptying the bucket. The further movement of the controlling drum releases the brake and throws in the reversing clutch, thus starting the hoist in the opposite direction, and also starting the traveling nut on the controlling mechanism in the opposite direction. At the end of the hoist the cycle of controlling movements is repeated and so on, making the hoisting operation continuous and automatic. Every attention has been given to the safe operation of the hoist. The main brake is of the gravity type and to be released the current must be on the solenoid operating the valve so that air can be admitted to the underside of the brake piston.

If for any reason, either the supply of current or of air pressure is interrupted,

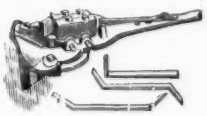
the valve drops, and the weights on brake lever set the brake. The clutches are designed so that they are thrown out by weights. As is the case with the brake, either clutch can only be thrown in when the current is on the solenoid, and the air pressure admitted under the piston, and if either current or pressure fail, the clutch is off. The motor shaft is fitted with an emergency brake operated by a weight controlled by a solenoid—any interruption in the flow of current to the motor sets the brake and stops the motor. Any interruption of the flow of the current stops the machine, throws out the clutches and puts

on the brake. A safety cut-out is provided for in the head frame so that in case a bucket is carried beyond the proper height, the current is cut off.

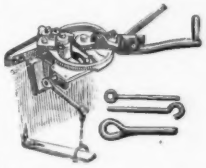
The head-frame is 93′ from the base to the center of the sheave at the top. It is built of structural steel. From the head-frame are suspended two buckets 6′ in diameter and 19′-6″ deep. The capacity of each bucket is seventeen tons of water. In the bottom of the bucket are located two lift gates with an area practically equal to the cross section of the bucket. These gates are lifted automatically when the bucket reaches the top, and the water is discharged through the bottom into a spout fitted below the bucket, and which deflects to either side of the shaft. Each bucket makes a complete round-trip in one minute and fifty seconds, the total lift being 555 feet.

Bending Tools.

THE Wallace Supply Company, 901 Garden City Block, Chicago, Ill., are offering the eye and the angle bender, illustrated herewith. The eye bender is made in two sizes, No. 1 taking stock up to and including ½ inch. It bends rings and eyes up to 2¾ inches outside diameter. No. 2 takes stock up to and including ¾ inch; it bends rings and eyes up to 3 inches, outside diameter. The machine bends hot stock and turns out perfect eyes and hooks, uniform in character and size. By the system of gripping the end of the stock and carrying it around, forming a pin, it enables the operator to turn eyes on the ends of long rods.



The angle bender is made in two sizes. No. 1 bends flat stock up to 2 inches wide by ⅜ inch thick, and a round or flat square stock up to ¾ inch. Clean, light corners can be made with this tool. Many light jobs can be bent cold. The No. 2 machine bends flat stock up to 4 inches wide by ½ inch thick, and a round or square stock up to 1 inch. It also bends ⅜x1½-inch stocks, and under, edgewise. It also bends angle iron if a triangular piece of stock is cut from the upper wing. The No. 2 bender takes a wide range of work for a hand machine and will be found valuable in many shops, although for light work the No. 1 machine is more convenient. The angle benders have a wide range of work, for with these machines an operator can bend right, acute, obtruse and bias angles; braces of any angle, stirrups, linings for snap flasks, cranks, staples, yokes, dash board frames, hammer traps, etc. Special dies are made for all kinds of bends.



Both eye and angle benders are so arranged that they can be easily and quickly adjusted to suit the various sizes of stock. To change the size of the eye one removes the pin around which the stock is formed, and a pin is inserted of the size required. The angle bender has movable die blocks to suit the different thickness of material, and also movable stock block and gauge. Both the angle and eye benders are secured removably to brackets which may be fastened to any anvil, forge frame or any other location convenient to the operator.

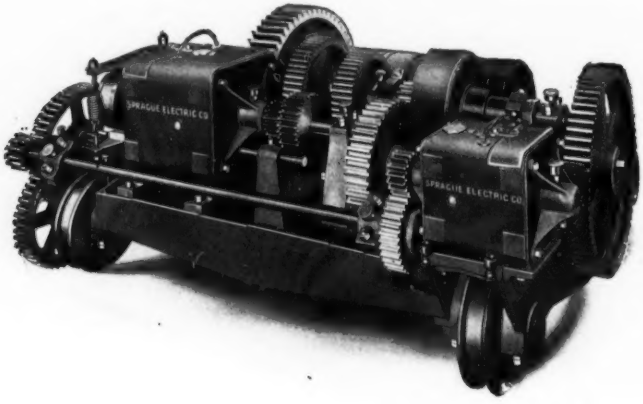
Electric Crane Motors.

ELECTRIC cranes are a most satisfactory means for meeting the requirements, in modern shops, for handling raw material and assembled parts with maximum speed and minimum cost, and, to meet the demand for a strong, reliable and efficient motor for crane service, the Sprague Electric Company has put on the marked their type "N" motors. Crane service requires motors specially adapted to its special line of work, and are more strongly constructed than the ordinary machine tool motor, in order to withstand the unusual strain which crane motors are called on to bear. Care has been taken, therefore, to make these type "N" motors exceptionally strong without being bulky.

The bearings are substantial, easily renewed and inspected, and are thoroughly protected against dirt. The field frames are rectangular in form and include a set of four bosses on each side and the bottom of the motor. Any one of these sets can be drilled and tapped for the support of the motor. The bearing shields which

support the armature form the ends of the motor field, and make it dust proof. These motors can thus be operated with perfect safety and certainty under shop conditions which would work injury to other types of motors used in crane service.

The Sprague crane motors readily lend themselves to the application of crane service without altering the existing designs. Special attention has been given to the design and construction of the brush holders with the result that even with the frequent reversals of direction required in the operation of crane motors a most satisfactory service is obtained. They are simple and compact, with ample capacity for carrying the current, and are mechanically strong, with nothing to work loose or get out of order.



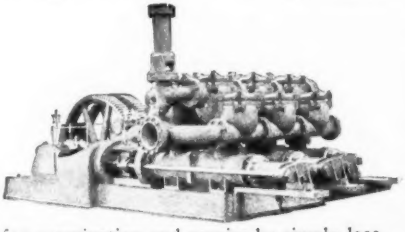
The brush holders are so designed that the carbon may be fed to the commutator until almost wholly used, with the tension on the brush being practically uniform throughout its whole life. The motors are wound so that no shifting of the brushes is necessary under any conditions of operation. They are fully enclosed so as to protect the working parts from fumes, dust and particles of foreign substances which are likely to rise in localities where cranes are used.

A full description of these motors may be obtained by addressing the manufacturers, Sprague Electric Company, 527 West 34th street, New York.

Electric Mine Pumps.

THE Goulds Manufacturing Co., Seneca Falls, N. Y., has for several years given special attention to electric pumps for mines. Hundreds of their efficient pumps are in use all over the world giving the best of satisfaction, and the renewal of orders from old customers is an evidence of the high esteem in which they are held by those that use them.

The Goulds double-acting triplex plunger mine pump, which is illustrated, was especially designed for mine service, and has many advantages. It is a "low down" pump requiring but a small amount of head room, and can be taken to pieces and lowered through an ordinary mine shaft. It is built in a number of sizes for elevations from 350 to 3,500 feet. The valves are all on top, where they can be easily reached



for examination and repairs by simply loosening the nuts that secure the valve box covers and dropping down the swing bolts. The plungers are outside packed and the cross heads are fitted with adjustable babbitted shoes which run in bored guides.

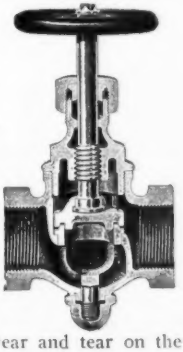
The double gears are of close grained cast iron and the pinions of steel, both machine cut from the solid.

The crank shaft is forged steel in two pieces and single throw with gears on the inner side. The crank shaft bearing surfaces have wedge and screw adjustment of special construction to keep the shafts in perfect alignment. The six cylinders are charcoal iron with heavy cast bronze lnings. The valves are extra heavy bronze with leather or rubber faces as may be desired, and where exceptionally gritty or acidulous water is to be handled especially constructed valves can be furnished.

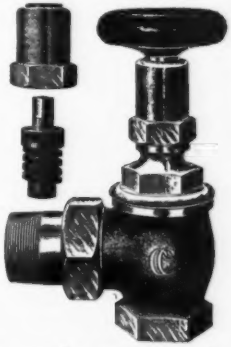
The pump illustrated is 7½" x 16", having a capacity of 660 gallons per minute against a pressure of 300 pounds or an elevation of 700 feet, and is furnished with a spring alleviator in place of an air chamber. Seven of these pumps 5½" x 16" have recently been installed in the DeBeers diamond mines, South Africa. The combined capacity is 3,600,000 gallons every 24 hours. They are located 1,300 feet below the surface and all connected to a common discharge. Each pump is direct connected to a Westinghouse electric motor.

A New Crane Valve.

CRANE CO. have recently brought out a line of improved renewable seat and disc globe and angle valves. These valves are suitable for working pressures up to 250 pounds and are tested to 700 pounds pressure per square inch. As the accompanying cuts will show they embody several new features in their construction which will be readily appreciated. The renewable parts are made of hard composition. They are especially suitable for any heavy duty where extreme pressure is used and where the wear and tear on the valve is mose severe.



By unscrewing the nut on bottom of the valve all parts are accessible and removable from the top, thus making it convenient to substitute a new seat or new disc when required, or to replace any worn part. The disc being attached to the stem by a slot, it is easily removed and replaced. The seat

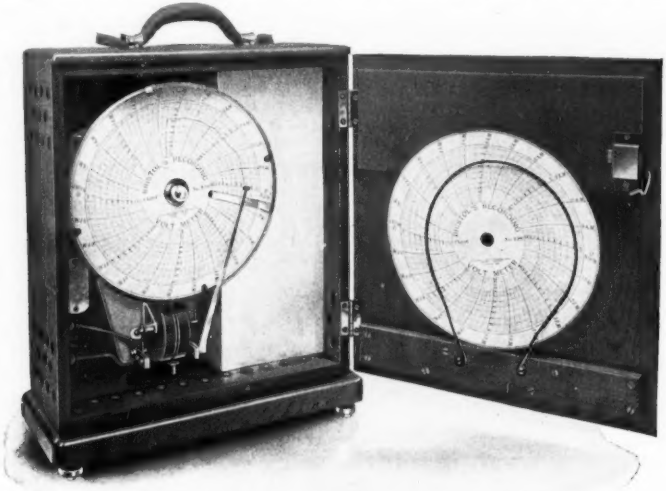


and disc can be removed and the two ground together if necessary. The construction of these valves is such that they may be packed when open without steam escaping.

New Recording Voltmeter.

THE importance of maintaining uniform voltage in the generation and distribution of electricity for light and power has long been appreciated by both the producer and the consumer. A variation of comparatively a small percentage in the voltage of an incandescent lighting circuit from the standard for which the lamps are designed causes great loss in the life of the lamps and results in wide fluctuations in the efficiency and candle power. In the application of electric power, as, for instance, on an electric railway, it is of great importance that the voltage be maintained regardless of the variations in the load. The recording voltmeter has proven itself to be of great value, and is an indispensable part of a modern electric plant, since it accurately, automatically and continuously furnishes a written record of the slightest variation of the voltage. The recording voltmeters manufactured by the Bristol Company, of Waterbury, Conn., have been extensively adopted, but up to the present it has been necessary to furnish the instruments with entirely different current coils, according as they were to be employed upon alternating or direct current circuits. In many electric plants both alternating and direct current are generated, and if

the same voltmeter can be used equally well for recording either kind of current, it is quite evident that a valuable advance has been made. This has been accomplished, and Fig. 1 illustrates the standard station or switch-board design. In Fig. 2 a special portable form of the instrument is shown. The case is provided with a handle and levelling screws for convenient transportation and adjustment. The door is open, showing the construction and manner of operation. The novel features and improvements to this new voltmeter are, first, it is equally applicable to both alternating or direct circuit; second, it requires only one-third as much current to operate as that necessary for the older design for alternating currents; third, it is more sensitive to very slight variations of voltage; fourth, the chart graduations are nearly uniform on both sides of the working range; fifth, the portable form of the instrument in its carrying case is only half the size and weight that was formerly required.



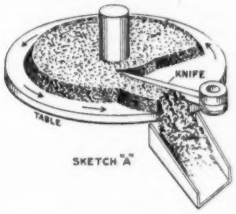
The solenoids shown in Fig. 2 are connected so that when current is passing through them in series, the movable solenoid will be repelled from, instead of being attracted towards, the stationary one. The movable solenoid is mounted on a frictionless knife edge multiplying device, which transmits its motion to the pen arm, carried by the knife edge blade. This simple multiplying device permits the solenoids to be located very near each other, and consequently the magnetic field of force is uniform throughout the motion of the solenoid resulting in the desirable scale divisions of the chart. By making the constructions of the solenoids so that there is repulsion instead of attraction, the mutual inductance between them is neutralized, thus making the same instrument suitable for recording either alternating or direct current. The instrument is independent of the rate of alternations and is compensated for changes of atmospheric temperature.

The Trump Measuring Machine.

THE Trump measuring machine consists of a horizontal revolving table on which rests the material to be measured, and a stationary knife set just above the table and pivoted on a vertical shaft outside the circumference. The knife can be adjusted to extend the proper distance into the material and peels off, at each revolution of the table, a certain amount which falls into the chute. The material peeled off is replaced from the supply contained in a bottomless storage cylinder somewhat smaller in diameter than the table, and revolving with it. The distance between the

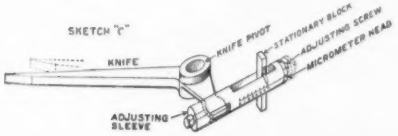
bottom of the cylinder and the table, the width of the knife and the depth of its cut determine the quantity measured off.

The depth of the cut is adjusted by swinging the knife around on its pivot so



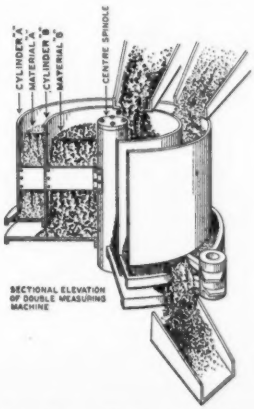
that it extends a greater or less distance into the material. This swing is controlled by a screw attached to an arm cast as part of the knife. A micrometer scale with pointer indicates the position of the knife.

When it is desired to measure off and



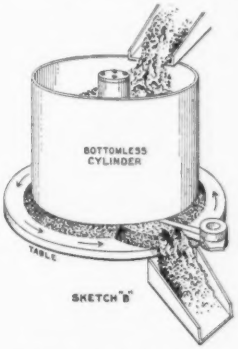
mix two or more materials, the machines are made with two or more tables set one above the other, and mounted on the same spindle so that they revolve together.

Each table has its own storage cylinder above it, the cylinders being placed one



within the other. There is a knife with its own adjusting mechanism for each table, which enables the user to vary at will the percentage of each material in the mixture. The materials flow together constantly and regularly in small streams into the common chute, the particles becoming intimately mixed; each infinitesimal amount of one ingredient being accompanied by the proper amounts of the other ingredients.

Materials can be fed to the storage cylinders by conveyors, by gravity from a storage bin, or by shoveling; and it is only necessary to see that enough is kept in the storage cylinders to insure that the amount which the knives peel off will be constant. With some finely powdered materials, which flow very freely, feeding-seals are placed at the top of the storage cylinders

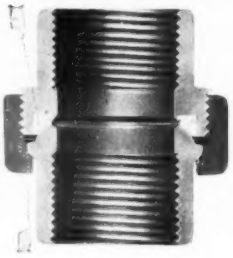


to regulate the density and pressure of the contents. The tables and storage cylinders are all mounted on and driven by the same center sleeve, which is carried on a dirt-proof step bearing provided with an oiling device. The lowest table has a bevel gear on the under side driven by a pinion mounted on a counter shaft. The casing of the machine is made dust-proof to prevent loss of materials or pollution of the air. The whole is self-contained on a substantial base, and can be driven by a motor or by any convenient shafting. Made by the Link-Belt Engineering Co., Philadelphia.

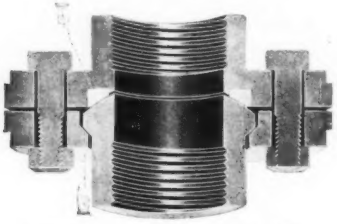
The Jefferson Union.

THE Jefferson union and coupling is made of malleable iron, having a bronze seat with the minimum amount to do the work effectively. It is so encased in iron that under no circumstances will it become loosened by the unequal expansion or contraction of the two metals. As shown in the illustration, it is protected from any liability of becoming injured or

dislodged by the pipe ends, no matter how far they are screwed in. Equally important is the added strength gained by having all made of malleable iron, so that the pipe ends never spread or get strained when connecting. It can be used over and over again, an impossibility with unions having brass ends. It is equally adapted to the use of steam, water, gas, or air, especially where high pressure is needed. In the construction of the East Boston tunnel it was subjected to 3,000 pounds' pressure per square inch, and did the work satisfactorily where other unions had failed. Being spherical in shape and thoroughly ground, becomes self-seating and very easily applied, doing away with all washers and gaskets. The Jefferson flange is made in all sizes from 1 inch to 12 inches by Jefferson Union Co., Lexington, Mass.



SECTIONAL VIEW.



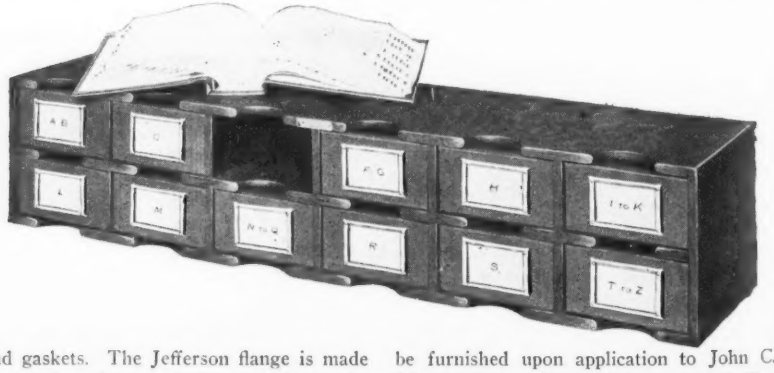
JEFFERSON THREE-PART FLANGE.

Loose Leaf Improvement.

THAT the card index has many inherent defects is recognized by everybody who has ever used one for any considerable time. Its flexibility, however, placed it far above bound books for reference records and it is probably more widely used than even the typewriter. A loose leaf binder is now to be had, however, which is claimed to excel the card index in convenience of recording and reference. The principal advantage comes through the book form of this loose leaf binder. It is much easier and more natural to open a book and refer to any page and make a notation if desired, than to search through a drawer, remove a card and find a suitable place to rest it before writing. Its place must be then found again to return the card, always with a chance of putting it in the wrong place.

For the proper housing of such record books special cabinets are made, as shown in the illustrations herewith. These range in capacity from two to twelve books, each book fitting in a separate dust-proof compartment. The twelve-volume cabinets, being made in sectional form, can be stacked together, a sufficient number making a complete cabinet of any desired size.

This loose leaf system suggests many possibilities in making and referring to any kind of record, and fuller information will be furnished upon application to John C. Moore Corporation, 313 Stone street, Rochester, N. Y.



NEWS SUPPLEMENT

The Engineering Magazine—December, 1905.

Personal.

—Arthur Warren has resigned his position as manager of publicity for Allis-Chalmers Co., and will sail for Europe on an important journalistic mission.

—Robert McF. Doble, consulting engineer, San Francisco, has severed his connection with the Abner Doble Co. in order to resume his individual practice.

—Charles W. Lawrie, for several years general superintendent of the Ball Engine Co., has accepted the position as general superintendent of the Reeves Engine Co., Trenton, N. J.

—Albert J. Pitkin, president of the American Locomotive Co., died November 16th. When the American Locomotive Co. was formed he was elected vice-president and after the death of President S. R. Calloway succeeded him.

—R. E. Mathot, a Belgian engineer well known in the United States as an authority on the construction and testing of gas engines and other internal-combustion motors, is at present in this country, and will visit a number of important industrial centers on a tour of inspection and consultation. Mr. Mathot has already been in New York, to which city he expects to return about December 10, being in Cincinnati on December 1, and in Pittsburg December 6-7, and he will be glad to meet and confer with engineers or manufacturers interested in the subject of modern internal-combustion motors, or to receive correspondence. Mr. Mathot may be reached through the offices of THE ENGINEERING MAGAZINE.

Industrial Notes.

—Broderick & Bascom Rope Co., St. Louis, have opened a branch office at 19 Murray street, New York.

—The Brooklyn Heights Railway Co. have recently placed an order with the Westinghouse Electric & Mfg. Co. for 300 No. 101-B Westinghouse D. C. railway motors and 150 sets of controllers.

—The Nevada Consolidated Copper Co., Nevada, has closed a contract with the Allis-Chalmers Co., Milwaukee, for a battery of six large sized McDougall roasting furnaces, each with six hearths.

—Chicago & Northwestern Railway have extensive plans on hand for the construction of a line across Wyoming; another across Dakota; and a third across Northern Wisconsin and the Michigan Peninsula. New towns are being opened on all of these newly constructed roads.

—The De La Vergne Machine Co., New York, have recently been given a contract for three 500 horse power Koerting gas engines to be direct connected to 325 kilowatt, 550 volt direct current Crocker-Wheeler generators for the Boston Elevated Co.

—R. D. Nuttall Co., Pittsburg, have lately installed one of the largest gear cutting machines for cutting gears by the milling process that is manufactured. This machine will allow them to cut spur gears up to 20 feet in diameter, 3 feet face and up to 7 inch P tooth.

—Owing to the steady growth of its business, the Pelton Water Wheel Co., San Francisco, is obliged to enlarge its works, and to that end has purchased a block of land in South San Francisco, where a modern machine shop is now under course of construction.

—The Yampa Smelting Co. have just closed a contract with the Allis-Chalmers Co., Milwaukee, for six McDougall furnaces, to be installed in the Salt Lake City plant. The furnaces are of the standard Klepetke-McDougall type, but with all the latest improvements in details.

—G. M. Gest, New York, has been awarded the contract for the construction of a complete subway system at Chattanooga, Tenn., for the East Tennessee Bell Telephone Co. This is the first conduit work installed in the City of Chattanooga and the system will be a very large one.

—The increasing business of the Morse Chain Co. has necessitated the building of a large new plant at Ithaca, N. Y., which will be operated in conjunction with the present factory of the company at Trumansburg, N. Y. It is their intention to make

this new plant a model one in every way and ample facilities for future expansion will be provided.

—Owing to the rapidly increasing Southern business, the De La Vergne Machine Co., New York, has established a branch agency at Atlanta, Ga. This agency is to cover the States of North Carolina, South Carolina, Alabama, Florida and Georgia. Their representative will be W. M. Hargreaves, and the office will be located at 510 Candler Building.

—Pratt & Whitney Co. have purchased a plant in Dundas, Ontario, for the manufacture of their full line of small tools. The building is a modern structure, and the power plant is already in place. The plant will also include a department for manufacturing a full line of twist drills, an elaborate equipment of special machinery having been installed for the purpose.

—The Model Stoker Co., Dayton, have equipped 1,000 horse power Stirling boilers with the Model automatic furnace for the Home Lighting, Power & Heating Co., Springfield, Ohio; also 1,000 horse power Wickes vertical boilers for the Saginaw Plate Glass Co., Saginaw, Mich; 1,200 horse power Stirling boilers for the Friend Paper Co., West Carrollton, Ohio, and 1,200 horse power for the B. F. Goodrich Co., Akron.

—The Westinghouse Electric & Manufacturing Co. will have a new line of ceiling and floor column fan meters on the market the coming season, both direct and alternating current. These fans will have four blades and ball bearings, and be finished in black enamel and oxidized copper. The alternating current fans will be of the induction type and the direct current fans will be furnished with three-point switches.

—Robins Conveying Belt Co., New York, has just closed a contract with the Bartlett, Hayward & Co., Baltimore, for belt conveyors intended for the retort house of the Astoria Light, Heat & Power Co. Among other work this company now has on hand is the manufacture of belt conveyors and elevators for the Burnham Coal Co., Boston, and of belt conveyors for the U. S. Smelting Co., Salt Lake City.

—The two most important buildings being erected in the retail districts of New York and Chicago are to be ventilated throughout by American Blower Co. apparatus. Eighteen large fans and heaters and tempering coils containing an aggregate of about sixty thousand feet of one inch pipe will be used in equipping the Altman Building, New York, and the Marshall Field Building, Chicago.

—Pittsburgh Gage & Supply Co., Pittsburgh, report the following concerns among recent purchasers of their white star oil filters: Wabash Clay Co., Veedersburg, Ind.; Lalande & Grosjean Mfg. Co., Harrisburg, Pa.; Campbell & Wright, Tuskegee, Ala.; Gilmore & Davis Co., Tallahassee, Fla.; Driggs-Seabury Ordnance Corporation, Sharon, Pa.; and Schmulbach Brewing Co., Wheeling, W. Va.

—Wellman - Seaver - Morgan Co., Cleveland, have been awarded by the United States Government, the contract for crane service over two ship building berths, at the U. S. Navy Yard at Mare Island, San Francisco. This is one of the most important contracts in this line that has been placed for a long time, comprising an immense steel trestle and a powerful high-speed cantilever gantry crane mounted on same and traversing over the two berths.

—Broderick & Bascom Rope Co., St. Louis, were awarded gold medals by the Lewis & Clark Centennial Exposition at Portland in the following groups: wire ropes, cables for transmission of power, aerial cables for transportation of ore, hawser steel cables for marine use, and wire rope and aerial cables for mining purposes of all kinds. They were also awarded a gold medal for originality of design of the exhibit.

—Plans are being prepared and building operations will commence at once on a four story brick and steel factory addition to the plant of The National-Acme Manufacturing Co., Cleveland. It is hoped to have the building in readiness for occupancy early in 1906. The four story addition built during the past summer afforded only slight and temporary relief to the crowded condition of all departments, and the present capacity will be more than doubled when the improvements under way have been carried out.

—The Pelton Water Wheel Co., San Francisco, has closed an important contract

with the Oro Water, Light & Power Co., Oroville, Cal. This covers two complete Pelton units of 2,000 horse power capacity each, direct connected to electric generators. Sturgess governors will be employed. Other recent orders are: a wheel equipment for the Crown Columbia Paper & Pulp Co., Washington, consisting of a triple Pelton unit for direct connection to heavy pulp grinders in the paper mills. Takata & Co. have ordered a 300 horse power unit for Tokio, and a large wheel has just been furnished the Ingersoll-Sergeant Drill Co. for direct connection to one of their compressors.

—Sullivan Machinery Co., Chicago, are installing for the North Carolina Granite Co., Mt. Airy, N. C., a Sullivan Corliss, two stage air compressor for driving the Sullivan drills and other compressed air appliances, used at its quarries. This compressor has a capacity of 2,000 cubic feet of free air per minute, at 78 revolutions. The air cylinders are connected to a Sullivan Corliss, cross compound, condensing steam end, especially designed and proportioned for this purpose. The air inlet valves are of the Corliss type, operated by independent eccentrics, and the discharge valves on both cylinders are of the automatic poppet type, moving in a direction parallel with the piston rod, with removable seats located in the cylinder heads. The devices for cooling the air during compression are unusually efficient. A similar machine is installed at the works of the Southern States Portland Cement Co., Rockmart, Ga.

—The Westinghouse Machine Co., Pittsburg, have received many orders for gas engines, ranging from 10 British horse power to 1,000 British horse power. One of the most recent orders was received from the Rockland Electric Co., Hillburn, N. Y., for two 500 horse power double acting horizontal tandem gas engines. Another order is one from The Union Traction Co. of Kansas, Independence, Kan., for one 500 horse power horizontal tandem gas engine and one 1,000 horse power horizontal twin tandem gas engine. Other orders were received from the Sherwin-Williams Co., Newark; American Sheet & Tin Plate Co., Pittsburg; The Sidney Electric Light Co., Sidney, Ohio; J. C. Sterns Electrical Co., Buffalo; American Snuff Co., New York; Northwestern Lithographing Co., Milwaukee; Granite City Hospital, Granite City, Ill.; American Locomotive Works, Allegheny, Pa.; American Acid & Alkali Co., Bradford, Pa.; Amolyo Mining Co., New York; Home Light, Heat & Power Co., Pittsburg, Kan.; Pittsburg (Pa.) City Hall.

NEW CATALOGUES AND TRADE PUBLICATIONS

These catalogues may be had free of charge on application to the firms issuing them. Please mention The Engineering Magazine when you write.

Air Compressors.

SULLIVAN MACHINERY CO., Chicago.—Catalogue No. 53, entitled "Modern Practice in Air Compression," containing a well-illustrated description of the many different types of air compressors manufactured by them. Also contains many tables giving much valuable data. 6 by 9 in.; pp. 128.

Drilling Tools.

ST. LOUIS WELL MACHINE & TOOL CO., St. Louis.—Circular 1, illustrating and describing the full line of drilling tools manufactured by them, together with prices, sizes, etc. 7½ by 10 in.; pp. 16.

Electric Drills.

CHICAGO PNEUMATIC TOOL CO., Chicago.—Special circular No. 52 containing an illustrated description of their air cooled Duntley electric drills, together with tables of tests. 9 by 6 in.; pp. 12.

Electrical Equipment.

FORT WAYNE ELECTRIC WORKS, Fort Wayne, Ind.—Bulletins Nos. 1067, 1068 and 1070 illustrating and describing type A transformers, type M induction motors and series A. C. arc lighting system respectively.

Foundry Supplies.

S. OBERMAYER CO., Cincinnati.—The Obermayer Bulletin for Septpember-October contains much information of a valuable nature to foundrymen. 6 by 9 in.; pp. 32.

Gas Engines.

FOOS GAS ENGINE CO., Springfield, Ohio.—Catalogue No. 16 treating of Foos gas and gasoline engines adapted to all power purposes. Illustrated. 10½ by 8 in.; pp. 40.

Gas Producers.

AUTOMATIC GAS PRODUCER CO., New York.—Pamphlet containing an illustrated description of

their automatic gas producer. Also contains table showing the analyses of gas made by the automatic gas producer from bituminous coal. 6 by 9 in.; pp. 10.

Gears.

R. D. Nuttall Co., Pittsburg.—Booklet entitled "Part of Plant and Product," printed in two colors, containing a brief description of their plant and products, together with many fine illustrations.

Heating Apparatus.

American Blower Co., Detroit.—Catalogue No. 186 describing "A B C" heating apparatus for the heating and ventilating of factories and public buildings and the drying of materials of all kinds. Is well printed and finely illustrated. 7 by 9 in.; pp. 32.

Hoisting Drum.

The Hayward Co., New York.—Well-printed booklet describing their hoisting drum. Illustrated. 3½ by 6 in.; pp. 12.

Hydraulic Accumulators.

Watson-Stillman Co., New York.—Catalogue No. 67, containing a description of their hydraulic accumulators and fittings, together with tables giving dimensions, prices, etc. 6 by 9 in.; pp. 68.

Hydro-Electric Plant.

The Arnold Co., Chicago.—Bulletin No. 13, describing in detail the hydro-electric plant of The Spring River Power Co., Joplin, Mo., including the transmission lines and sub-stations. 9 by 12 in.; pp. 16.

Ice Machines.

Larsen Ice Machine Co., Omaha.—Catalogue, printed in two colors, containing an illustrated description of the Larsen ice machines, together with a partial list of plants recently installed. 10 by 8 in.; pp. 48.

Mine Locomotives.

Jeffrey Manufacturing Co., Columbus, O.—Bulletin No. 10, illustrating and describing the many different styles and sizes of mine locomotives manufactured by them. Is well printed and contains many views showing the locomotives in operation. 8 by 10 in.; pp. 68.

Mechanical Machinists' Tools.

Brown & Sharpe Mfg. Co., Providence.—Catalogue No. 107, containing a description, together with price lists, of their mechanical machinists' tools. 6 by 9 in.; pp. 164.

Oil Engines.

De La Vergne Machine Co., New York.—Catalogue treating of the Hornsby-Akroyd oil engines. Contains numerous testimonial letters and a list of users. Is well printed and illustrated. 9 by 6 in.; pp. 74.

Pipe Crushing Machine.

United Engineering and Foundry Co., Pittsburg.—Leaflet containing a brief description, with two illustrations, of their pipe crushing and shearing machine for use in tube mills, steel plants and scrap yards.

Power Presses.

E. W. Bliss Co., Brooklyn.—Catalogue containing a brief description, together with illustrations, of the many different styles of power presses for manufacturing pieced tin and iron work. 5 by 7 in.; pp. 80.

Pumps.

Emerson Steam Pump Co., Alexandria, Va.—Catalogue containing an illustrated description of their pumps, together with many illustrations showing the pumps in operation. Quick cleaning strainers and foot valves are also treated. 6 by 9 in.; pp. 38.

Rotary Converters.

Westinghouse Electric and Manufacturing Co., Pittsburg.—Special publication No. 7038, treating of Westinghouse rotary converters, their characteristics and construction, with instructions for their erection, operation and care. 6 by 9 in.; pp. 68.

Saw Mill Cariages.

Allis-Chalmers Co., Milwaukee.—Catalogue No. 123, containing an illustrated description of their saw mill carriages and accessory machinery, together with views showing many recent installations. 8 by 10½ in.; pp. 48. Also pamphlets illustrating and describing their steam shovels; Hancock jig; McDougall roasting furnace; single-stage centrifugal pumps; and high-duty plunger pump.

Separators.

Austin Separator Co., Detroit.—Catalogue No. 15, illustrating and describing their extensive line of separators. The subject matter in this catalogue is a complete exposition of the theory and principles of construction of the best types of separators. Also contains numerous testimonial letters. 6 by 9 in.; pp. 52.

Steam Specialties.

Watson & McDaniel Co., Philadelphia.—Booklet, pocket size, containing an illustrated description of their full line of steam specialties for power plants and steam heating. 3¾ by 6½ in.; pp. 48.

Stone Working Tools.

Ingersoll-Rand Co., New York.—Bulletin No. 2004, issued by their pneumatic tool department, illustrating and describing their pneumatic stone working tools. 6 by 9 in.; pp. 16.

Storage Batteries.

Westinghouse Machine Co., Pittsburg.—Small folder issued by the storage battery department, devoted chiefly to illustrations of their storage batteries for railway signal service.

Tool Steel.

Wm. Jessop & Sons, Ltd., New York.—New catalogue of sizes of tool and other kinds of steel. Also contains much valuable information on the hardening and tempering of tool and die steel. 3½ by 6 in.; pp. 56.

Well Drilling Machinery.

American Well Works, Aurora, Ill.—Bulletin No. 95, containing illustrations and description of the different sizes and styles of well-drilling machinery manufactured by them. Bulletin No. 94 treats of artesian well pumping machinery.